POLARAD®

HANDBOOK OF OPERATING AND MAINTENANCE INSTRUCTIONS

MICROWAVE SIGNAL GENERATORS MODELS MSG-1R AND MSG-2R

POLARAD ELECTRONIC INSTRUMENTS,
DIVISION OF POLARAD ELECTRONICS CORPORATION
34-02 QUEENS BLVD., LONG ISLAND CITY 1, N. Y.

POLARAD®

INSTRUCTION MANUAL

MICROWAVE
SIGNAL GENERATORS
MODELS
MSG-1R AND MSG-2R

This handbook covers equipment prefixed by the following serial numbers:

MSG-1R: 121 TO 200 & 3-1 & UP
MSG-2R: 126 TO 200 & 4-1 & UP

POLARAD ELECTRONIC INSTRUMENTS
A DIVISION OF POLARAD ELECTRONICS CORPORATION
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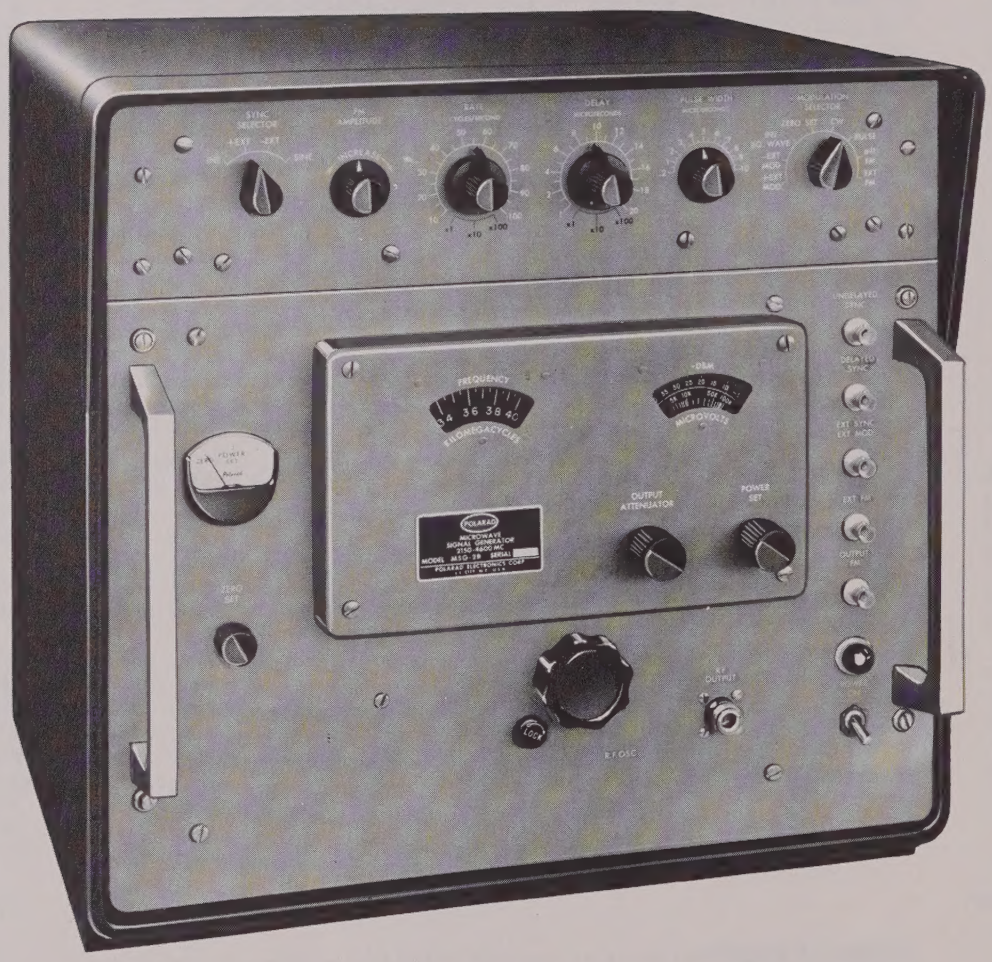


Figure 1-1. Model MSG-2R Microwave Signal Generator.

SECTION I

INTRODUCTION

1—1. SCOPE OF MANUAL.

1-2. This handbook contains instructions for the Models MSG-1R and MSG-2R Microwave Signal Generators, manufactured by the Polarad Electronic Instruments Division of Polarad Electronics Corporation, Long Island City, New York. The manual includes a general description of the equipment, operating instructions required for normal use, theory of operation, maintenance information, and schematic diagrams.

1—3. PURPOSE AND USE OF THE EQUIPMENT

1-4. The Polarad Models MSG-1R and MSG-2R Microwave Signals Generators are precision instruments designed to generate low-power cw (continuous-wave), frequency-modulated, square-wave-modulated, and pulse-modulated radio-frequency energy of a known power level over the frequency range from 0.95 to 4.6 gc. The equipment provides facilities for testing and aligning broad and narrow band microwave systems and components such as antennas, attenuators, beacons, crystal mounts, hybrid junctions, preselectors, radar sets, receivers, and r-f amplifiers. Specific measurements that can be performed include antenna gain, antenna patterns, attenuation, bandwidth, conversion gain, frequency, image rejection, power gain, selectivity, signal-to-noise ratio, SWR, and transmission-line characteristics.

1—5. GENERAL DESCRIPTION.

1-6. The Models MSG-1R and MSG-2R Microwave Signal Generators are versatile instruments which combine high accuracy with simplicity of operation and portability. The two available r-f tuning units are of the separate plug-in type. The broadband external-cavity reflex klystron oscillator in both the Models MSG-1R and MSG-2R Tuning Units permit continuous tuning over the 0.95 to 2.4 gc and 2.0 to 4.6 gc frequency ranges, respectively. The removable Model GM-3 Pulse Modulator Unit provides conventional pulse, square-wave, or frequency-modulation capabilities. The Model GB-1 Basic Unit contains the regulated power supplies which are mounted on removable subchassis. This method of construction facilitates servicing and alignment of the equipment.

1-7. The MSG-1R and MSG-2R Microwave Signal Generators (hereafter referred to as the MSG-1R/2R) are housed in sturdy, attractively-hooded aluminum cabinets of modern design, and present a neat and pleasing appearance. Internal components are cooled by a blower fan mounted on the basic unit, thereby assuring reliable operation and longer component life. The equipment has been ruggedly constructed to operate dependably through extreme climatic and environmental conditions.

1—8. EQUIPMENT SUPPLIED.

1-9. The MSG-1R/2R consists of a basic unit, a modulator unit, one of two available plug-in tuning units, various cable assemblies, and accessories as listed in table 1-1.

TABLE 1-1. EQUIPMENT SUPPLIED

Component	Polarad Model or Part Number
Basic Unit	Model GB-1
Pulse Modulator Unit	Model GM-3
Tuning Unit	Model MSG-1R
Tuning Unit	Model MSG-2R
Power Cable Assembly (10 ft)	B111144
Power Cable Adapter	A131966
R-f Cable Assembly (6 ft)	B12551
Video Cable Assembly (6 ft)	B12553
Wrench Kit*	A25109

* See table 1-2.

TABLE 1-2. WRENCH KIT TOOLS

Tool	Polarad Part No.
Spanner Wrench	A15550
#4 Spline Wrench	A515101
#6 Spline Wrench	A515102
#8 Spline Wrench	A515103
#10 Spline Wrench	A515104
#4 Allen Wrench	A515301
#6 Allen Wrench	A515302
#8 Allen Wrench	A515303
#10 Allen Wrench	A515304

1—10. GENERAL ELECTRICAL CHARACTERISTICS.

1-11. The general electrical characteristics and capabilities of the MSG-1R/2R are listed below:

Frequency range:	
Model MSG-1R	0.95 to 2.4 gc
Model MSG-2R	2.0 to 4.6 gc
Frequency accuracy	±1% of FREQUENCY KILOMEGACYCLES dial indication
Maximum calibrated output power	1 milliwatt (0 dbm)
Output power range	0 to -127 dbm
Output attenuator accuracy	±2db
Output VSWR	2:1 (maximum)
Output connector	Type N
Modulation capabilities	Cw, fm, pulse, and square-wave
Internal pulse:	
Repetition rate	10 to 10,000 pps, continuously adjustable
Pulse width	0.3 to 10 microseconds, continuously adjustable
Pulse rise time	0.1 microsecond (maximum)
Pulse decay time	0.1 microsecond (maximum)
Pulse delay	2 to 2,000 microseconds, continuously adjustable
Internal square-wave:	
Repetition rate	10 to 10,000 cps, continuously adjustable
Internal fm:	
Type	Linear sawtooth
Repetition rate	10 to 10,000 cps, continuously adjustable
Frequency deviation	0 to at least ±2.5 mc of center frequency, continuously adjustable
External pulse:	
Polarity	Positive or negative
Repetition rate	10 to 10,000 pps
Pulse width	0.2 to 50,000 microseconds
Amplitude	15 to 40 volts (peak)

(Cont'd)

External fm:

Type	Sawtooth, sine-wave, or complex wave
Frequency	100 to 100,000 cps
Amplitude	50 volts (peak-to-peak)

Ouput synchronizing pulses:

Type	Undelayed and delayed
Polarity	Positive
Repetition rate	10 to 10,000 pps, continuously adjustable
Amplitude	15 volts peak (minimum)
Rise time	0.25 microsecond (maximum)
Decay time	0.25 microsecond (maximum)
Pulse delay	2 to 2,000 microseconds, continuously adjustable

Sync input requirements:

Type	Sine-wave, square-wave, or pulse
Polarity	Positive or negative
Pulse amplitude	5 to 50 volts (peak)
Sine-wave amplitude	5 to 40 volts (rms)
Power input requirements	115 or 230 volts ±10%, 50 to 60 cps, 300 watts

1—12. ELECTRON TUBE, SEMICONDUCTOR DIODE, FUSE,AND INDICATOR LAMP COMPLEMENT.

1-13. Table 1-3 lists the types and functions of the complement of electron tubes and semiconductor diodes employed in the equipment. The types and functions of the fuses and indicator lamps used in the equipment are listed in table 1-4.

TABLE 1-3. ELECTRON TUBE AND SEMICONDUCTOR DIODE COMPLEMENT

Reference Symbol Number	Electron Tube or Semiconductor Diode Type	Function
Model GB-1 Basic Unit		
CR1 through CR4	SD94A	Full-wave rectifier
CR100	A100211	Full-wave rectifier
CR105	1N96A	Protective diode
CR106	SD94A	Protective diode
V1	6336	Series regulator
V2	12AX7	D-c amplifier
V3	OB2	Voltage regulator
V4	5Y3GT	Full-wave rectifier
V5	6080	Series regulator
V6	12AX7	D-c amplifier
V7	5Y3GT	Full-wave rectifier
V8	6AQ5	Series regulator
V9	12AX7	D-c amplifier
V10	5651	Voltage regulator
Model GM-3 Pulse Modulator Unit		
CR302	1N464	Limiting diode
CR303 and CR304	1N126	Clippers
V301	5725	Rate phantastron and fm generator
V302	6U8	A- Cathode follower B- Square-wave generator
V303	12AU7	A- Puller amplifier B- Puller amplifier
V304	5687	A- Undelayed sync blocking oscillator B- Delayed sync blocking oscillator

(Cont'd)

TABLE 1-3. ELECTRON TUBE AND SEMICONDUCTOR DIODE COMPLEMENT (Cont'd)

Reference Symbol Number	Electron Tube or Semiconductor Diode Type	Function
Model GM-3 Pulse Modulator Unit (continued)		
V305	6U8	A- Phase inverter B- Clipper amplifier
V306	5687	Schmitt trigger
V307	6CL6	Output amplifier
V308	12AU7	A- Cathode follower B- Buffer amplifier
V309	5725	Delay phantastron
V310	6AN8	Width multivibrator
Model MSG-1R Tuning Unit		
CR101	SD95A	Protective diode
V100	5814	Beam current regulator
V101	5687	Keyer amplifier
V13	5837	R-f oscillator
Model MSG-2R Tuning Unit		
CR101	SD95A	Protective diode
V100	5814	Beam current regulator
V101	5687	Keyer amplifier
V13	5836	R-f oscillator

TABLE 1-4. FUSE AND INDICATOR LAMP COMPLEMENT

Reference Symbol Number	Type	Function
FUSES		
F1 and F2	3 amp (SLO-BLO)	Power line protective fuses (located in basic unit)
INDICATOR LAMPS		
DS1	NE 51	POWER ON indicator lamp (located in tuning unit)
DS2	47	Dial illumination lamp (located in tuning unit)

SECTION II

OPERATION

2—1. GENERAL.

2-2. The MSG-1R/2R is shipped complete and is ready to use upon delivery; no special or permanent installation procedures are necessary. The equipment can be used in either field or laboratory applications. It should be unpacked upon receipt, observing the usual precautions for unpacking a delicate instrument.

WARNING

THE MSG-1R/2R (WITH THE TUNING UNIT INSTALLED) WEIGHS APPROXIMATELY 95 POUNDS. IT IS STRONGLY RECOMMENDED THAT TWO PERSONS BE EMPLOYED AT ALL TIMES WHEN UNPACKING, LIFTING, TRANSPORTING, OR REPACKING THE EQUIPMENT.

2—3. EQUIPMENT INSTALLATION.

2-4. After unpacking the equipment, plan its installation. The MSG-1R/2R is supplied mounted in a cabinet for either bench or cart use. The unit is also available (on special order only) in either a protruding-panel or flush-panel configuration for rack mounting.

a. Figure 2-1 illustrates the cabinet-mounted MSG-1R/2R.

b. Figure 2-2 illustrates the protruding-panel rack-mounted MSG-1R/2R.

c. Figure 2-3 illustrates the flush-panel rack-mounted MSG-1R/2R.

2—5. OPERATION.

2-6. The procedures for proper operation of the MSG-1R/2R are described in paragraphs 2-7 through 2-16.

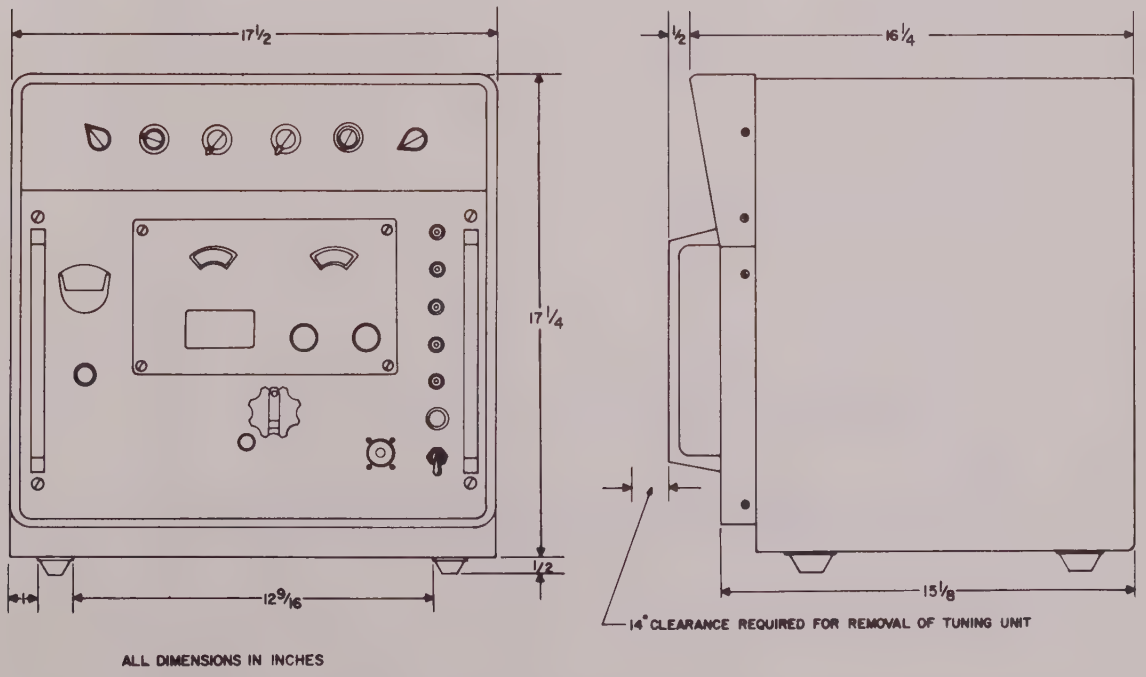


Figure 2-1. Model MSG-1R/2R Microwave Signal Generator, Installation Outline Drawing

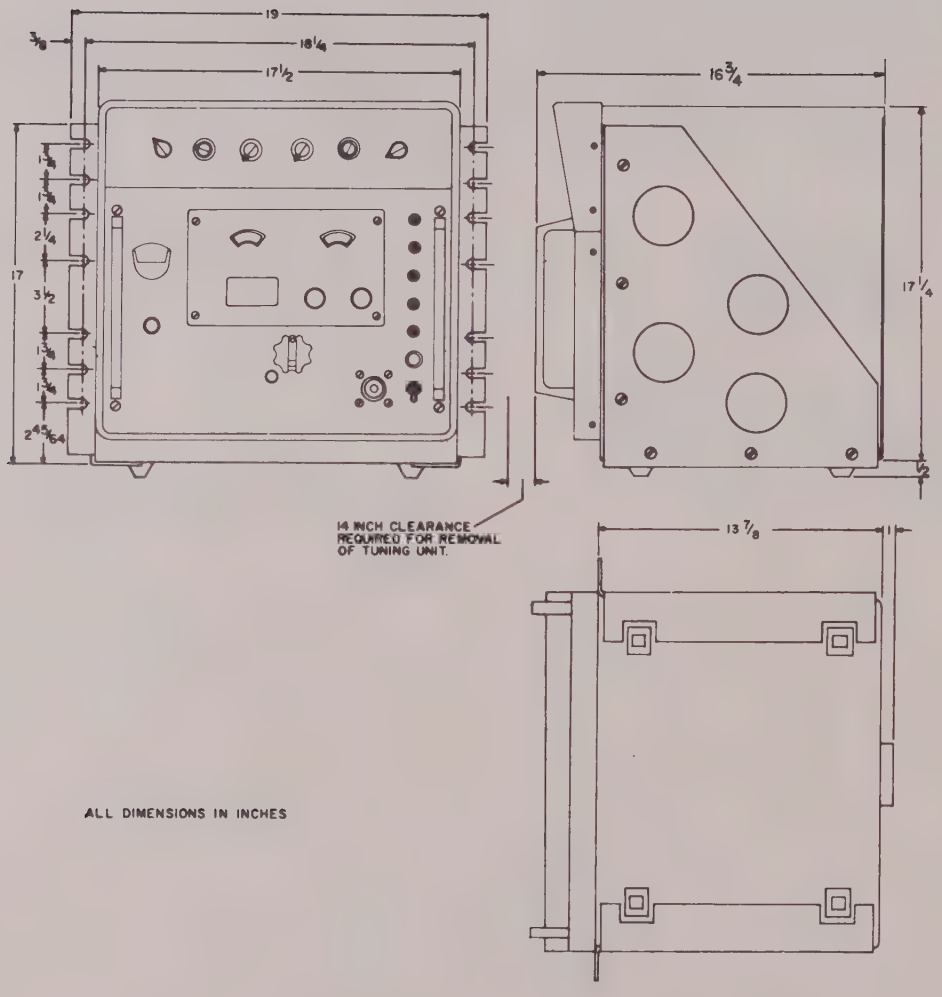


Figure 2-2. Model MSG-1R/2R Microwave Signal Generator (Protruding-Panel Rack-Mounted Configuration), Installation Outline Drawing

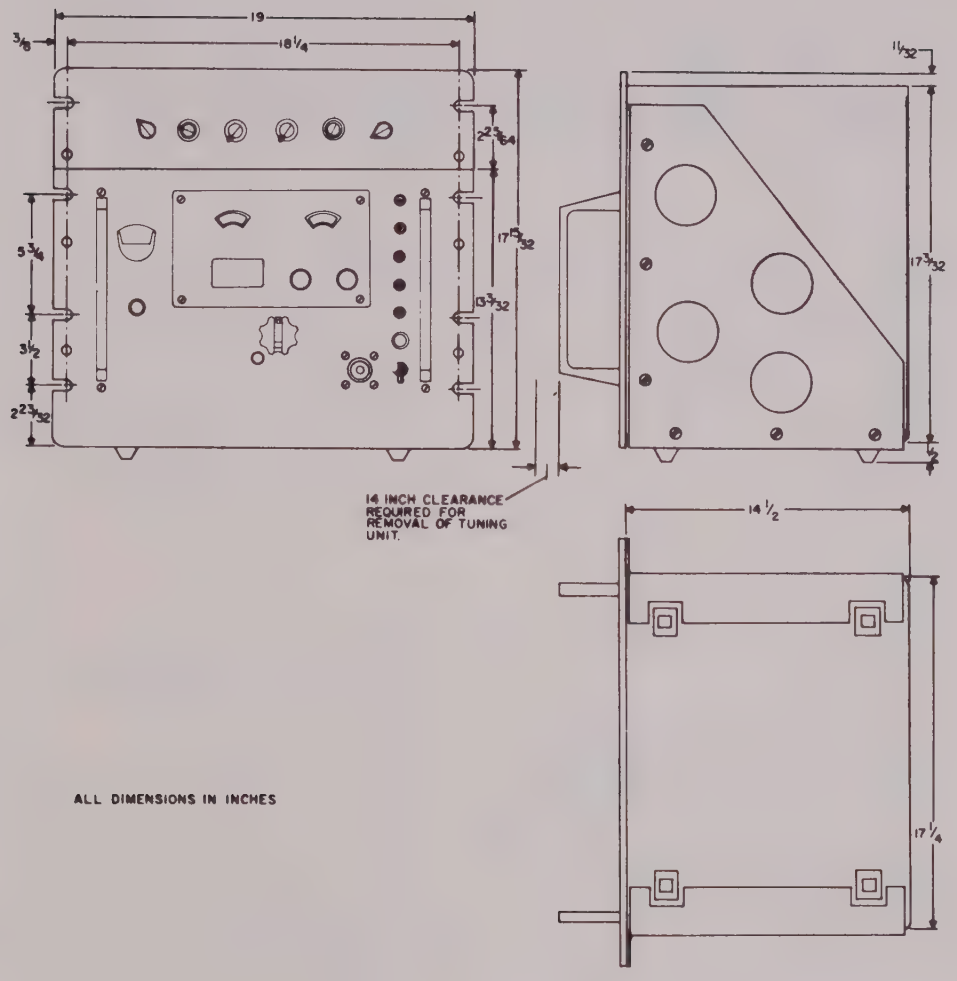


Figure 2-3. Model MSG-1R/2R Microwave Signal Generator (Flush-Panel Rack-Mounted Configuration), Installation Outline Drawing

2-7. OPERATING CONTROLS, INDICATORS, AND CONNECTORS. The operating controls, indicators, and connectors necessary for the operation of the MSG-1R/2R are located on the modulator unit and tuning unit front panel assemblies, as illustrated in figure 2-4; their functions are described in table 2-1.

2-8. STARTING PROCEDURE. The starting procedure for the MSG-1R/2R is described in the following steps:

CAUTION

THE MSG-1R/2R IS FACTORY SET FOR OPERATION ON A 115-VOLT, 50-60 CPS A-C POWER LINE. SHOULD OPERATION ON A 230-VOLT, 50-60 CPS A-C POWER LINE BE DESIRED, SET THE 115/230V SWITCH (LOCATED AT THE REAR OF THE MSG-1R/2R) TO THE 230V POSITION. FAILURE TO DO THIS WILL RESULT IN THE EQUIPMENT DRAWING EXCESSIVE CURRENT, THEREBY CAUSING THE POWER LINE PROTECTIVE FUSES TO BLOW.

a. Set the POWER ON switch to "off."

b. Determine the voltage available at the a-c power source outlet to be used.

c. Remove the MSG-1R/2R from its dust cover and set 115/230V switch S2 (located at the rear of the basic unit) to the position corresponding to the supply voltage. Replace the MSG-1R/2R into its dust cover and secure the two to each other.

d. Connect the female end of the supplied 10-ft polarized power cable assembly to POWER INPUT 115/230V 50-60 CPS receptacle J1 (located at the rear of the MSG-1R/2R).

e. Connect the male end of the power cable assembly (through the supplied power cable adapter, if necessary) to the power source outlet.

f. Set the POWER ON switch to POWER ON. The POWER ON indicator will immediately become illuminated, indicating that primary power is being supplied to the power transformers in the basic unit power supply.

g. Allow the MSG-1R/2R to warm up and stabilize for at least 15 minutes before using the equipment.

2-9. SETTING FREQUENCY AND CALIBRATING OUTPUT POWER. Operation of the MSG-1R/2R requires setting the r-f oscillator to the desired operating frequency and calibrating the r-f output power level. The procedure for setting frequency and calibrating output power is described in the following steps:

a. Rotate the LOCK control counterclockwise to permit adjustment of the RF OSC control.

b. Adjust the RF OSC control until the desired operating frequency is indicated below the FREQUENCY KILOMEGACYCLES dial hairline.

c. Rotate the LOCK control clockwise to lock the setting of the RF OSC control.

d. Set the MODULATION SELECTOR switch to ZERO SET.

e. Adjust the ZERO SET control to obtain a power monitor meter indication of ZERO.

f. Set the MODULATION SELECTOR switch to CW.

g. Adjust the POWER SET control to obtain a power monitor meter indication of POWER SET. The MSG-1R/2R is now calibrated at a one miliwatt (0 dbm) power reference level at the desired operating frequency.

Note

When the operating frequency of the MSG-1R/2R is altered, the entire procedure for setting the frequency and calibrating the output power level must be repeated.

Setting the MODULATION SELECTOR switch to any position other than CW (after calibrating the output power level) will be accompanied by a reduction in the indication of the power monitor meter. This signifies that the average r-f power developed when the r-f oscillator is modulated is less than the average r-f power developed when the r-f oscillator is generating a cw signal.

2-10. CW OPERATION. To obtain a cw (continuous-wave) r-f output signal from the MSG-1R/2R, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired frequency (refer to paragraph 2-9).

b. Adjust the OUTPUT ATTENUATOR control to obtain the desired r-f output power level, as indicated on the -DBM MICROVOLTS dial.

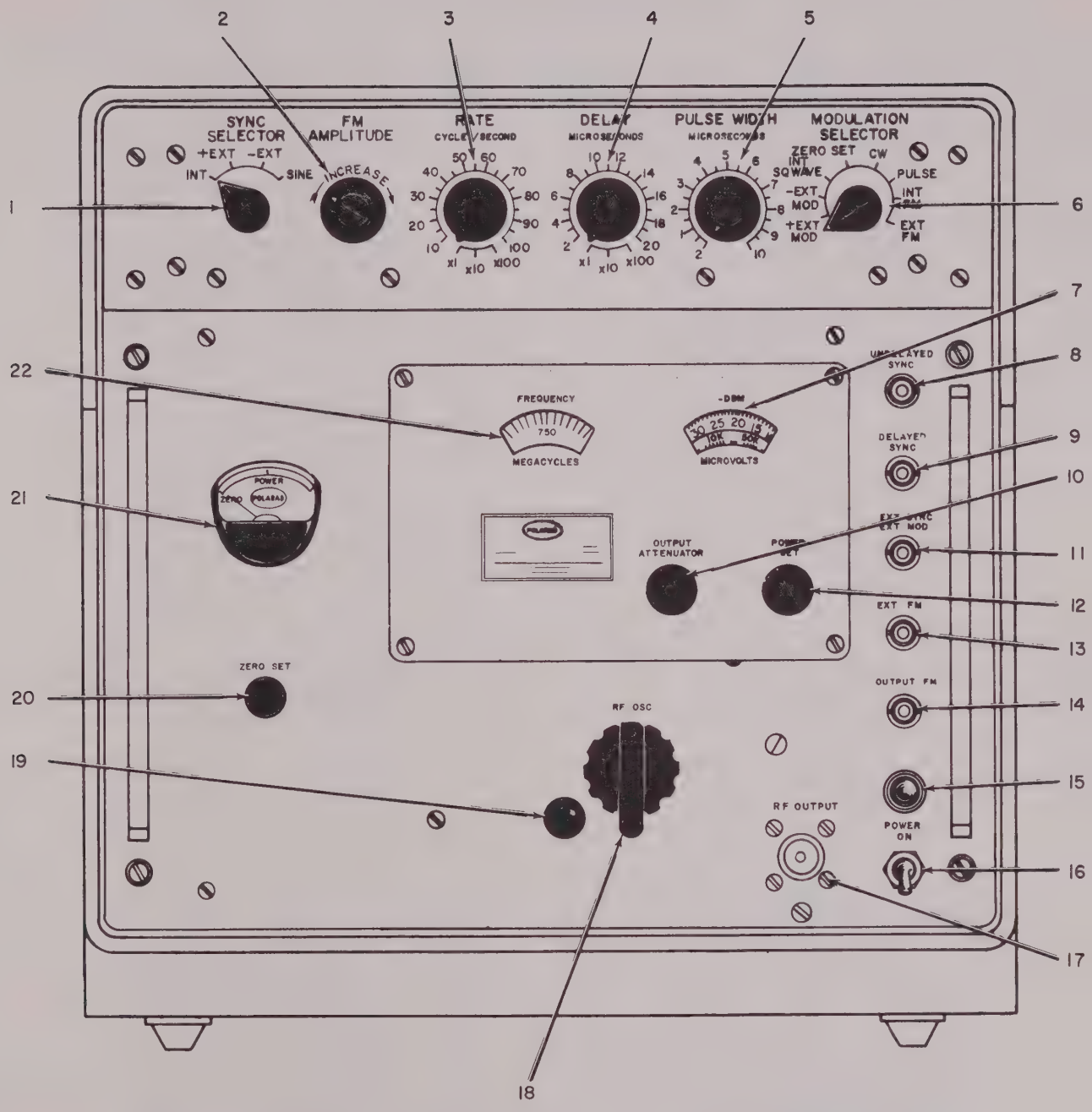


Figure 2-4. MSG-1R/2R Front Panel Operating Controls, Indicators, and Connectors

TABLE 2-1. FRONT PANEL OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Control, Indicator, or Connector	Figure 2-4 Index Number	Function
SYNC SELECTOR switch	1	Permits modulated r-f output signal to be either internally or externally synchronized, as follows: INT-- modulation repetition frequency determined by RATE CYCLES/SECOND control and RATE CYCLES/SECOND switch when MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position; +EXT-- modulation repetition frequency determined by that of externally generated positive trigger pulse train when MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position; -EXT--modulation repetition frequency determined by that of externally generated negative trigger pulse train when MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position; SINE - modulation repetition frequency determined by that of externally generated sine-wave signal when MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position
FM AMPLITUDE control	2	Permits adjustment of the frequency deviation about center frequency by varying magnitude of sawtooth signal applied to repeller of r-f oscillator when MODULATION SELECTOR switch is in INT FM position
RATE CYCLES/SECOND control and RATE CYCLES/SECOND switch	3	Permits setting of modulation repetition frequency when SYNC SELECTOR switch is in INT position and MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position
DELAY MICROSECONDS control and DELAY MICROSECONDS switch	4	Permits adjustment of delay between undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the r-f output pulse from 2 to 2,000 microseconds

(Cont'd)

TABLE 2-1. FRONT PANEL OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont'd)

Control, Indicator, or Connector	Figure 2-4 Index Number	Function
PULSE WIDTH MICROSECONDS control	5	Permits adjustment of r-f output pulse width from 0.3 to 10 microseconds when MODULATION SELECTOR switch is in PULSE position
MODULATION SELECTOR switch	6	Permits selection of type of r-f output signal - cw, internally synchronized square-wave, internally synchronized pulse, internally synchronized fm, externally synchronized pulse, external fm, or external pulse
-DBM MICROVOLTS dial	7	Indicates level of r-f output signal in both -dbm and microvolts (into a 50-ohm load)
UNDELAYED SYNC connector	8	Provides positive video trigger pulse which leads both r-f output pulse and delayed sync output pulse in time when MODULATION SELECTOR switch is in +EXT, -EXT, INT SQ WAVE, PULSE, or INT FM position
DELAYED SYNC connector	9	Provides positive video trigger pulses in time coincidence with leading edge of r-f output pulse when MODULATION SELECTOR switch is in +EXT, -EXT, INT SQ WAVE, PULSE, or INT FM position
OUTPUT ATTENUATOR control	10	Permits adjustment of r-f output signal power level from 0 to -127 dbm
EXT SYNC/EXT MOD connector	11	Permits external synchronization and external modulation of equipment, as follows: EXT SYNC-- with SYNC SELECTOR switch in position corresponding to externally generated synchronizing signal, repetition rate of modulation is determined by external sync signal when MODULATION SELECTOR switch is in INT SQ WAVE, PULSE, or INT FM position; EXT MOD-- with SYNC SELECTOR switch set to position corresponding to polarity

(Cont'd)

TABLE 2-1. FRONT PANEL OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Cont'd)

Control, Indicator, or Connector	Figure 2-4 Index Number	Function
EXT SYNC/EXT MOD connector (continued)		of externally generated modulating pulse, modulated r-f output pulse is determined by external modulation signal when MODULATION SELECTOR switch is in EXT MOD position
POWER SET control	12	Permits setting of reference power level at one milliwatt (0 dbm), as indicated by a power monitor meter reading of POWER SET
EXT FM connector	13	Couples externally generated signal to repeller of r-f oscillator when MODULATION SELECTOR switch is in EXT FM position
OUTPUT FM connector	14	Couples internally generated sawtooth signal to external test equipment
POWER ON indicator	15	Illuminates (red) upon application of operating power
POWER ON switch	16	Controls operating power to the equipment
RF OUTPUT connector	17	Couples r-f output signal to equipment or component under test
RF OSC control	18	Permits adjustment of r-f oscillator frequency
LOCK control	19	Permits locking of RF OSC control at desired operating frequency
ZERO SET control	20	Permits balancing of internal thermistor bridge, as indicated by a power monitor meter reading of ZERO, when MODULATION SELECTOR switch is in ZERO SET position
Power monitor meter	21	Provides visual indication when zero-setting and power-setting the equipment
FREQUENCY KILO-MEGACYCLES dial	22	Indicates operating frequency of r-f oscillator

(Cont'd)

Note

The r-f output power level at the RF OUTPUT connector is indicated in both -dbm and microvolts (into a 50-ohm load) on the -DBM MICROVOLTS dial. The upper scale is calibrated to read directly in -dbm and the lower scale to read directly in microvolts.

c. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the item being tested.

2-11. INTERNALLY SYNCHRONIZED SQUARE-WAVE-MODULATED OPERATION. To obtain an internally synchronized square-wave-modulated r-f output signal from the MSG-1R/2R, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to INT SQ WAVE.

c. Set the SYNC SELECTOR switch to INT.

d. Set the RATE CYCLES/SECOND switch and adjust the RATE CYCLES/SECOND control to obtain the desired repetition frequency.

e. Adjust the OUTPUT ATTENUATOR control to obtain the desired r-f output power level, as indicated on the -DBM MICROVOLTS dial.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power level of a cw signal having the same peak power level as the square-wave-modulated r-f output signal available at the RF OUTPUT connector.

f. Set the DELAY MICROSECONDS switch and adjust the DELAY MICROSECONDS control to obtain the desired delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the square-wave-modulated r-f output signal.

Note

The maximum delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the square-wave-modulated r-f output signal is limited by circuit design to 2,000 microseconds or 75% of the pulse period, whichever is smaller. Adjustment of the DELAY MICROSECONDS switch and DELAY MICROSECONDS control for greater delays will result in false indications. See figure 2-5.

g. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

h. Connect the 6-ft video cable assembly supplied between the UNDELAYED SYNC connector or the DELAYED SYNC connector, as required, and the appropriate input of the unit being tested and/or auxiliary test equipment.

2-12. INTERNALLY SYNCHRONIZED PULSE-MODULATED OPERATION. To obtain an internally synchronized pulse-modulated r-f output signal from the MSG-1R/2R, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to PULSE.

c. Set the SYNC SELECTOR switch to INT.

d. Set the RATE CYCLES/SECOND switch and adjust the RATE CYCLES/SECOND control to obtain the desired pulse repetition rate.

e. Adjust the PULSE WIDTH MICROSECONDS control to obtain an output pulse having the desired width.

f. Adjust the OUTPUT ATTENUATOR control to obtain the desired r-f output power level, as indicated on the -DBM MICROVOLTS dial.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power level of a cw signal having the same peak power level as the pulse-modulated r-f output signal available at the RF OUTPUT connector.

g. Set the DELAY MICROSECONDS switch and adjust the DELAY MICROSECONDS control to obtain the desired delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the pulse-modulated r-f output signal.

Note

The maximum delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the pulse-modulated r-f output signal is limited by circuit design to 2,000 microseconds or 75% of the pulse period, whichever is smaller. Adjustment of the DELAY MICROSECONDS switch and DELAY MICROSECONDS control for greater delays will result in false indications. See figure 2-5.

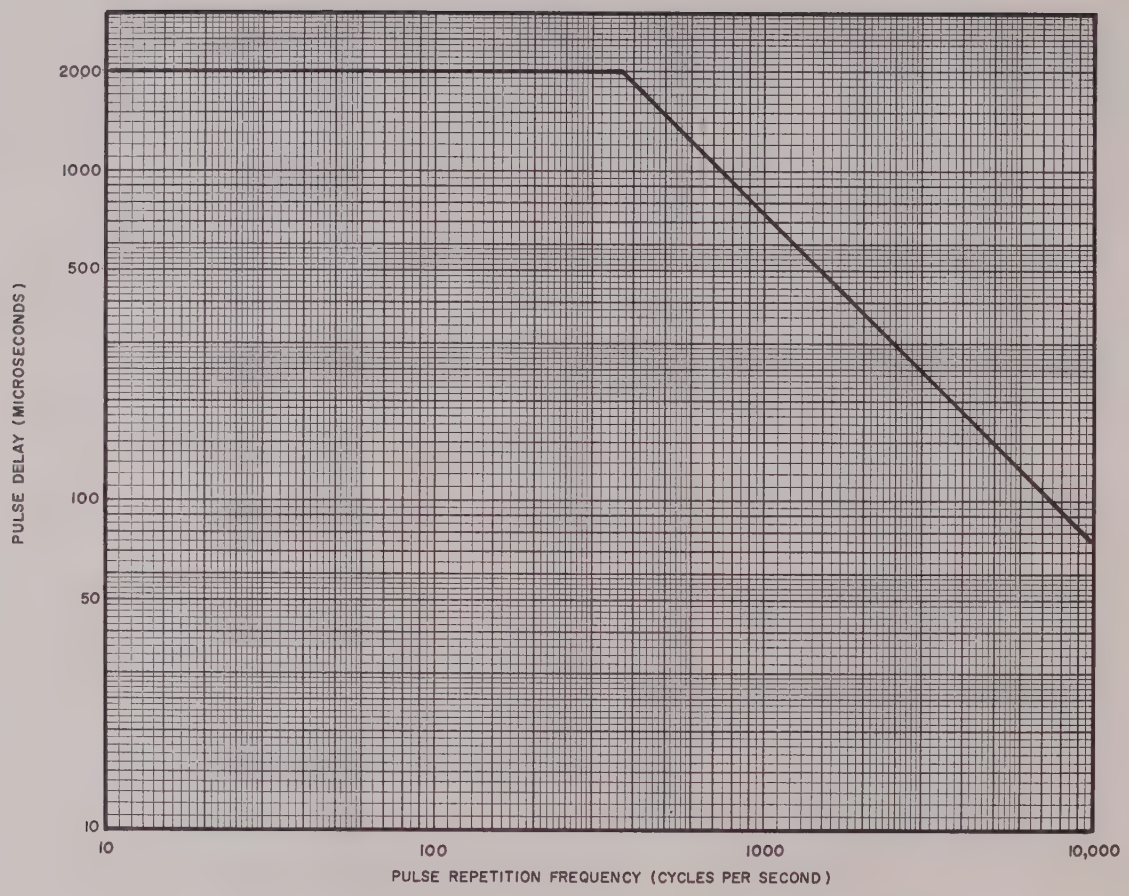


Figure 2-5. Maximum Pulse Delay as a Function of Repetition Rate

h. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

i. Couple the DELAYED SYNC connector and/or the UNDELAYED SYNC connector, as required, to the unit being tested and/or auxiliary test equipment.

2-13. EXTERNALLY SYNCHRONIZED PULSE-MODULATED OPERATION. To obtain an externally synchronized pulse-modulated r-f output signal from the MSG-1R/2R, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to PULSE.

c. Set the SYNC SELECTOR switch to +EXT, -EXT, or SINE, as determined by the nature of the externally generated synchronizing signal.

d. Couple the externally generated synchronizing signal to the EXT SYNC/EXT MOD connector.

e. Adjust the PULSE WIDTH MICROSECONDS control to obtain an output pulse having the desired width.

f. Adjust the OUTPUT ATTENUATOR control to obtain an r-f output signal of desired power level, as indicated on the -DBM MICROVOLTS dial.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power of a cw signal having the same peak power level as the externally synchronized pulse-modulated r-f output signal available at the RF OUTPUT connector.

g. Set the DELAY MICROSECONDS switch and adjust the DELAY MICROSECONDS control to obtain the desired delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the externally synchronized pulse-modulated r-f output signal.

Note

The maximum delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the externally synchronized pulse-modulated r-f output signal is limited by circuit design to 2,000 microseconds or 75% of the pulse period, whichever is smaller. Adjustment of the DELAY MICROSECONDS switch and the DELAY MICROSECONDS control for greater delays will result in false indications. See figure 2-5.

h. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

i. Couple the DELAYED SYNC connector and/or the UNDELAYED SYNC connector, as required, to the unit being tested and/or auxiliary test equipment.

2-14. EXTERNAL PULSE-MODULATED OPERATION. To obtain an r-f output pulse from the MSG-1R/2R which has the same characteristics as an externally available pulse, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to +EXT or -EXT, as determined by the polarity of the externally available modulating pulse.

c. Couple the externally available modulating pulse to the EXT SYNC/EXT MOD connector.

d. Adjust the OUTPUT ATTENUATOR control to obtain an r-f output signal of desired power level, as indicated on the -DBM MICROVOLTS dial.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power of a cw signal having the same peak power level as the externally modulated r-f signal available at the RF OUTPUT connector.

e. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

2-15. INTERNALLY SYNCHRONIZED FREQUENCY-MODULATED OPERATION. To obtain an internally synchronized frequency-modulated r-f output from the MSG-1R/2R, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to INT FM.

c. Set the SYNC SELECTOR switch to INT.

d. Adjust the RATE CYCLES/SECOND control and set the RATE CYCLES/SECOND switch to obtain the desired repetition rate.

e. Adjust the FM AMPLITUDE control to obtain the desired frequency deviation about the center frequency.

f. Set the DELAY MICROSECONDS switch and adjust the DELAY MICROSECONDS control to obtain the desired delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the frequency-modulated r-f output signal.

Note

The maximum delay between the undelayed sync output pulse and both the delayed sync output pulse and the leading edge of the frequency-modulated r-f output signal is limited by circuit design to 2,000 microseconds or 75% of the pulse period, whichever is smaller. Adjustment of the DELAY MICROSECONDS control and the DELAY MICROSECONDS switch for greater delays will result in false indications. See figure 2-5.

g. Adjust the OUTPUT ATTENUATOR control to obtain the desired r-f output power level, as indicated on the -DBM MICROVOLTS dial.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power of a cw signal having the same peak power level as the frequency-modulated r-f output signal at the frequency to which the MSG-1R/2R is tuned.

h. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

i. Couple the DELAYED SYNC connector and/or the UNDELAYED SYNC connector, as required, to the unit being tested and/or auxiliary test equipment.

2-16. EXTERNAL FREQUENCY-MODULATED OPERATION. To obtain an r-f output signal that is frequency-modulated by an externally generated sawtooth or sine-wave voltage, proceed as described in the following steps:

a. Calibrate the output power reference level at the desired operating frequency (refer to paragraph 2-9).

b. Set the MODULATION SELECTOR switch to EXT FM.

c. Couple the externally generated modulating voltage to the EXT FM connector.

d. Adjust the OUTPUT ATTENUATOR control to obtain an r-f output signal of desired power level, as indicated on the -DBM MICROVOLTS dial.

e. Connect the 6-ft r-f cable assembly supplied between the RF OUTPUT connector and the input connector of the unit being tested.

Note

The power level indicated on the -DBM MICROVOLTS dial corresponds to the average power of a cw signal having the same peak value as the externally modulated r-f signal at the frequency to which the MSG-1R/2R is tuned.

SECTION III

THEORY OF OPERATION

3—1. GENERAL.

3-2. Microwave Signal Generators MSG-1R and MSG-2R are precision instruments capable of generating low-power continuous-wave (cw), frequency-modulated, square-wave-modulated, and pulse-modulated r-f signals of known frequency and intensity over the frequency range from 0.95 to 4.60 gc. In addition to providing r-f test signals at the equipment front RF OUTPUT connector, the MSG-1R/2R also provides undelayed and delayed positive video trigger pulses for application to external test equipment. These pulses are available at the UNDELAYED SYNC and DELAYED SYNC connectors, respectively, when the MSG-1R/2R is programmed for either intenally or externally synchronized pulse-modulated operation, internally synchronized square-wave-modulated operation, or intenally synchronized frequency-modulated operation.

3—3. SIMPLIFIED BLOCK DIAGRAM ANALYSIS.

3-4. The MSG-1R/2R consists of a modulator, keyer, klystron r-f oscillator, power monitor, and the power supplies necessary to energize these circuits, as shown in figure 3-1. When pulse or square-wave modulation is programmed, the modulator generates the required pulsed signals, which are coupled to the control grid of the r-f oscillator through the keyer, thereby permitting oscillations at desired intervals and repetition rates. Frequency-modulated operation is accomplished by sweeping the repeller of the r-f oscillator with a sawtooth voltage generated within the modulator. A portion of the power developed by the r-f oscillator is applied to a thermistor bridge network as a means of calibrating the r-f power output level at one milliwatt (0 dbm).

3—5. DETAILED BLOCK DIAGRAM ANALYSIS.

3-6. ZERO SET OPERATION. When MODULATION SELECTOR switch S301 is in the ZERO SET position (see figure 3-2), the modulator section of the MSG-1R/2R is unenergized and a negative potential is applied to the control grid of r-f oscillator V13 via keyer amplifier V101. This negative potential is of sufficient magnitude to drive the tube beyond cutoff, thereby permitting the operator to balance the thermistor bridge by adjusting ZERO SET control R100.

3-7. CW OPERATION. When MODULATION SELECTOR switch S201 is in the CW position (see figure 3-2), the modulator section of the MSG-1R/2R remains de-energized (as in ZERO SET operation). A positive voltage is applied to the control grid of r-f oscillator V13 (via keyer amplifier V101), thereby permitting oscillation. The output level of the r-f signal is calibrated at one milliwatt (0 dbm) by adjusting the POWER SET control until the power monitor meter pointer deflects to an indication of POWER SET. The r-f power level available at the RF OUTPUT connector is then determined by the setting of the OUTPUT ATTENUATOR control.

3-8. INTERNALLY SYNCHRONIZED PULSE-MODULATED OPERATION. When MODULATION SELECTOR switch S301 is in the PULSE position and SYNC SELECTOR switch S300 is in the INT position (see figure 3-2), a pulsed signal appearing at the screen grid of rate phantastron and fm generator V301 is coupled to width multivibrator V310 through the delay circuitry (refer to paragraph 3-13). The width of the pulse developed by V310 is determined by the setting of PULSE WIDTH MICROSECONDS control C332, The output of V310 is coupled to the control grid of r-f oscillator V13 via output amplifier V307 and keyer amplifier V101.

3-9. INTERNALLY SYNCHRONIZED SQUIARE-WAVE-MODULATED OPERATION. When MODULATION SELECTOR switch S301 is in the INT SQ WAVE position and SYNC SELECTOR switch S300 is in the INT position (see figure 3-2), the square-wave signal obtained from square-wave generator V302B is coupled to the control grid of r-f oscillator V13 via output amplifier V307 and keyer amplifier V101.

3-10. INTERNALLY SYNCHRONIZED FREQUENCY-MODULATED OPERATION. Positioning MODULATION SELECTOR switch S301 to the INT FM position (See figure 3-2) couples a sawtooth signal appearing at the output of cathode follower V302A to the repeller of r-f oscillator V13. The magnitude of this sawtooth signal, and hence the frequency excursion of the modulated output signal, is adjusted by FM AMPLITUDE control R318.

3-11. EXTERNAL PULSE-MODULATED OPERATION. When MODULATION SELECTOR switch S301 is in the +EXT MOD or -EXT MOD position (see figure 3-2), and SYNC SELECTOR switch S300 is in the +EXT or -EXT position, respectively (depending on the polarity of the modulating pulse), the applied modulating pulse is coupled through phase inverter V305A and applied to the control grid of r-f oscillator V13 via output amplifier V307 and keyer amplifier V101.

3-12. EXTERNAL FREQUENCY-MODULATED OPERATION. Switching MODULATION SELECTOR switch S301 to EXT FM (see figure 3-2). routes the applied modulating signal directly to the repeller of r-f oscillator V13.

3-13. INTERNAL SYNCHRONIZATION. When SYNC SELECTOR switch S300 is in the INT position (see figure 3-2) and MODULATION SELECTOR switch S301 is in the INT SQ WAVE, PULSE, or INT FM position, the pulsed signal appearing at the screen grid of rate phantastron and fm generator V301 is coupled through puller amplifier V303A and undelayed sync blocking oscillator V304A, the latter producing a positive video trigger pulse which is available at UNDELAYED SYNC connector J105. The output of undelayed sync blocking oscillator V304A is also coupled to delay phantastron V309, which, in conjunction with DELAY MICROSECONDS control R367, DELAY MICROSECONDS switch S303, and cathode follower V308A, delays the video trigger pulse. This delayed pulse is coupled through buffer amplifier V308B and puller amplifier V303B to delayed sync blocking oscillator V304B. The output of delayed sync blocking oscillator V304B, a positive delayed trigger pulse is available at DELAYED SYNC connector J106. The positive pulse is also coupled to width multivibrator V310.

3-14. EXTERNAL SYNCHRONIZATION. Positioning SYNC SELECTOR switch S300 to +EXT, -EXT, or SINE (see figure 3-2), depending on the type of synchronizing signal employed, and MODULATION SELECTOR switch S301 to INT FM, INT SQ WAVE, or PULSE, couples an externally applied synchronizing signal through phase inverter V305A, clipper amplifier V305B, Schmitt trigger V306, and the delay circuitry. The delayed sync output pulse appearing at the cathode of delayed sync blocking oscillator V304B is coupled to the screen grid of rate phantastron and rate generator V301 for externally synchronized square-wave-modulated and externally synchronized frequency-modulated operation. For externally synchronized pulse-modulated operation, the delayed sync pulse is coupled to width multivibrator V310.

3—15. DETAILED CIRCUIT ANALYSIS, MODEL GM—3 PULSE MODULATOR UNIT.

3-16. Paragraphs 3-17 through 3-35 contain a detailed analysis of the various circuits comprising the Model GM-3 Pulse Modulator Unit.

3-17. PHANTASTRON RATE GENERATOR. The phantastron rate generator (see figures 3-2 and 5-3) provides the timing reference for the internally synchronized modulation capabilities of the equipment. The generator is comprised of rate phantastron and fm generator V301 and cathode follower V302A, which combine to form a free-running screen-coupled phantastron rate generator.

3-18. Rate phantastron and fm generator V301 employs a pentode with two control grids. The suppressor grid has a sharp cutoff characteristic, and is used as an independent control element. Initially, the screen grid (pin 6) is conducting heavily, while the suppressor grid (pin 7) is effectively cutting-off the plate (pin 5) current. The instantaneous plate voltage is at its maximum value. At the same time, the control grid is at cathode voltage due to R302 and R303 in series. The presence of any transient negative pulse at the plate of V301 is routed back to the control grid of V301 via cathode follower V302A. This action results in diminshed screen current and a corresponding rise in screen voltage. This voltage change is capacitively coupled to the suppressor grid (pin 7) through C303, causing the suppressor grid to initiate and maintain the plate current. The plate current now rises (with the plate voltage dropping) at a rate determined by the R-C time constant of the grid circuit (RATE CYCLES/SECOND control R301 and the capacitance inserted by RATE CYCLES/SECOND switch S302). Waveform linearity is obtained by the feedback between the plate and grid. The drop in plate voltage continues until the tube saturates. At this point the control grid voltage reverts to its normal zero bias condition, causing the screen and suppressor potentials to be restored to their original values.

3-19. SQUARE-WAVE GENERATOR V302B. When the MODULATION SELECTOR switch is in the INT SQ WAVE position (see figures 3-2 and 5-3), the sawtooth voltage appearing at the cathode of V302A is coupled to the control grid of square-wave generator V302B. The bias voltage of this tube is set, by means of Symmetry control R321, to place the cutoff point of the tube midway between the maximum and minimum voltages at the cathode of V302A. In this manner the output at the plate of V302B is a square wave.

3-20. Puller Amplifier V303A. Puller amplifier V303A (see figures 3-2 and 5-3) is a class B amplifier with fixed grid bias. The plate circuit contains one winding of feedback transformer T301 and load resistor R334 (which is shared with undelayed sync blocking oscillator V304A). The output of V301 is coupled through puller amplifier V303A to trigger undelayed sync blocking oscillator V304A.

3-21. UNDELAYED SYNC BLOCKING OSCILLATOR V304A. Undelayed sync blocking oscillator V304A (see figures 3-2 and 5-3) receives the positive pulses from the plate of puller amplifier V303A and transforms them into short-duration positive pulses. These pulses are then simultaneously applied to UNDELAYED SYNC connector J105 and to the suppressor of delay phantastron V309.

3-22. Blocking Oscillator V304A operates with a fixed bias provided by the -150 volt and -325 volt supplies and the voltage divider network consisting of R329 and R331. Capacitor C308 charges to a constant voltage of approximately -172 volts and offers a low impedance to ground for any pulse appearing at the grid. The negative-going pulse appearing at the plates

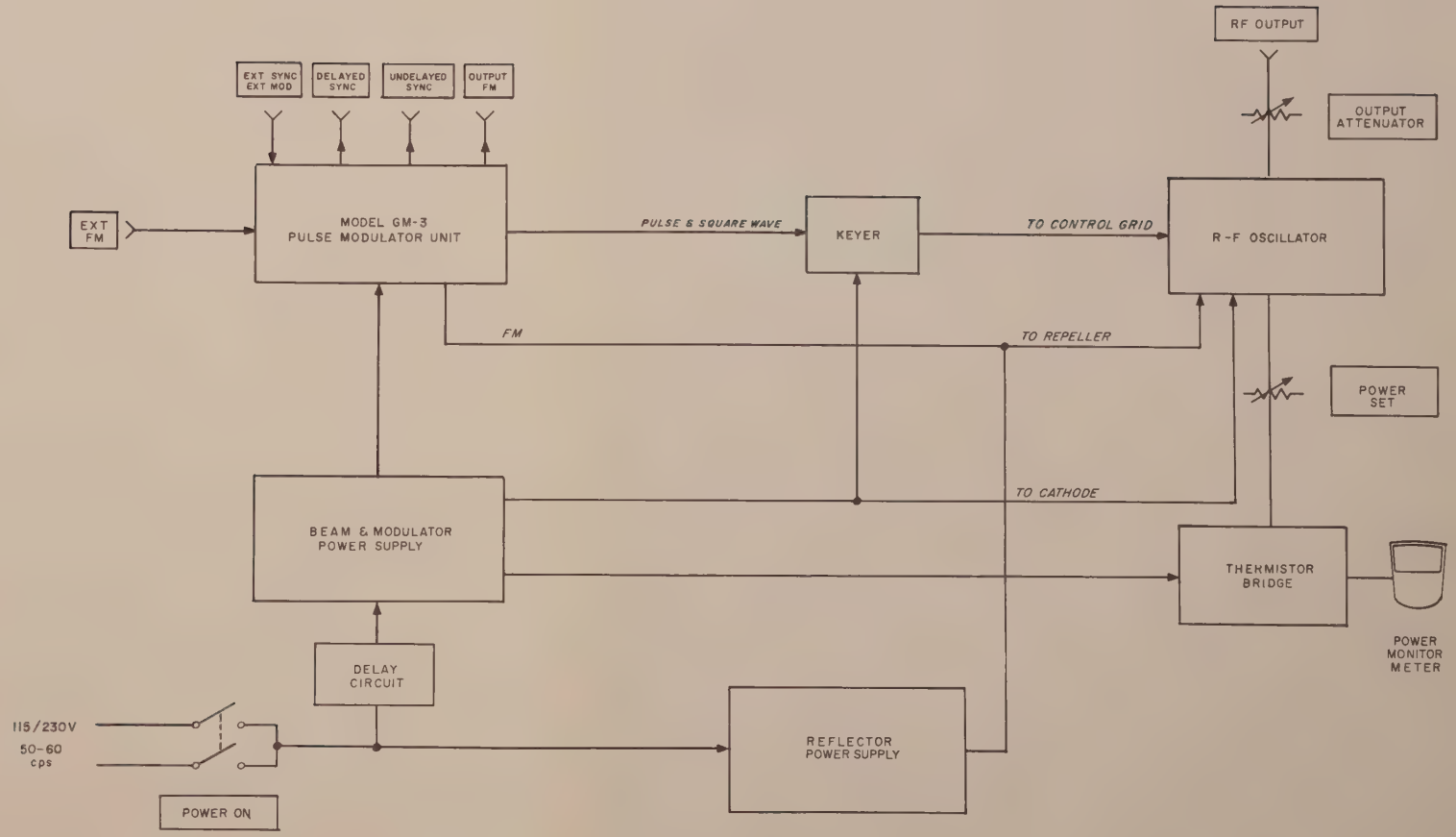


Figure 3-1. Models MSG-1R and MSG-2R Microwave Signal Generators, Simplified Block Diagram.

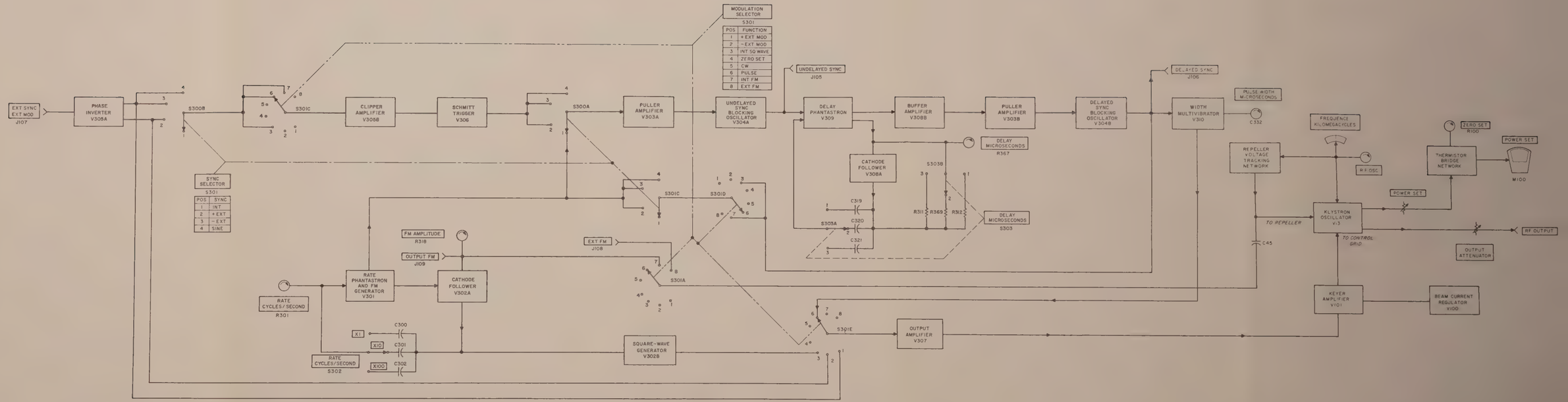


Figure 3-2. Models MSG-1R and MSG-2R Microwave Signal Generators, Detailed Block Diagram.

of V303A and V304A are coupled to the grid circuit of V304A through transformer T301. T301 inverts the polarity of the pulses by virtue of the manner in which it is wound, and the signal appears as positive pulses at the grid. A condition is therefore imposed such that a fall in plate voltage is accomplanied by a rise in grid voltage, which demands an additional drop in plate voltage. This action is cumulative until the plate bottoms, or saturates, and no additional plate current can be drawn. No change in plate current exists and, therefore, no flux linkage to induce the signal in the grid cirucit. At this point the plate begins to rise and the grid is forced to fall correspondingly. The plate potential rises beyond the plate supply voltage because of the inductive characteristics of T301, which behaves as an open-circuit when it is first presented with a fast-rising function. The impedance of the transformer gradually falls and the result is an overshoot. The output, however, is taken at the cathode, thereby presenting a low-impedance positive pulse to UNDELAYED SYNC connector J105. The cathode pulse is also differentiated, clipped, and applied to the suppressor grid of delay phantastron V309.

3-23. DELAY PHANTASTRON V309 AND CATHODE FOLLOWER V308A. Delay phantastron V309 (see figures 3-2 and 5-3) functions as a normally-off rate generator which responds to a positive pulse applied to its suppressor grid. Cathode follower V308A is employed to speed up the recovery time with no increase in gain or phase inversion. While in the quiescent state, the suppressor grid of V309 is maintained at a high negative potential through the voltage divider network consisting of R375 and R376.

3-24. The positive undelayed sync pulse at the cathode of V304A is coupled to the suppressor of delay phantastron V309. This positive trigger allows the plate to draw current. The plate voltage then drops, the grid voltage drops proportionally, the cathode current falls, and the screen voltage rises. This causes the suppressor voltage to rise, since it is obtained from the same bleeder as the suppressor. The plate potential then runs down linearly as a rate generator circuit. The end of this period comes when the control grid goes positive again, resulting in an increase in cathode current, in suppressor cutoff, and heavy screen current. The delay is adjusted by varying the RC time constant and by varying the plate starting potential. DELAY MICROSECONDS switch S303 inserts the proper resistor-capacitor network into the plate-grid circuit, thereby changing the delay range. Fine adjustment of the delay is obtained by DELAY MICROSECONDS control R367.

3-25. The delayed pulse is taken off the screen grid of V309 and applied to the control grid of buffer amplifier V308B.

3-26. BUFFER AMPLIFIER V308B. Buffer amplifier V308B (see figures 3-2 and 5-3) isolates, amplifies, inverts, and differentiates the output of delay phantastron V309. The positive pulse at the screen of V309 is applied to the grid of V308B. The signal developed at the plate is somewhat irregular and is composed of positive and negative spikes. Because of the inversion and differentiation properties of V308B, the negative spike corresponds to the leading edge of the input pulse, while the positive spike corresponds to the trailing edge. The output of V308B is then coupled to the control grid of puller amplifier V303B.

3-27. PULLER AMPLIFIER V303B. Puller amplifier V303B (see figures 3-2 and 5-3) operates in much the same fashion as V303A (refer to paragraph 3-20). V303B, however, couples the output of buffer amplifier V308B to trigger delayed sync blocking oscillator V304B.

3-28. DELAYED SYNC BLOCKING OSCILLATOR V304B. Delayed sync blocking oscillator V304B (see figures 3-2 and 5-3) provides short-duration positive pulses to DELAYED SYNC connector J106 and, simultaneously, the pulses required to trigger width multivibrator V310 (refer to paragraph 3-29). V304B is held below cutoff by a fixed negative potential tapped from the -325 volt and -150 volt supplies through R383 and R384. The delayed sync blocking oscillator is triggered by the negative-going spike from the plate of puller amplifier V303B, and the output pulse is developed in the same manner as described for undelayed sync blocking oscillator V304A (refer to paragraph 3-21).

3-29. WIDTH MULTIVIBRATOR V310. Width multivibrator V310 (see figures 3-2 and 5-3) is a conventional mono-stable multivibrator which produces positive output pulses adjustable from 0.3 to 10 microseconds in width. The width of the output pulse is determined by the setting of PULSE WIDTH MICROSECONDS control C332, in conjunction with Min Width Adj control C399 and Max Width Adj. control R399. The rectangular positive pulse appearing at the plate of the pentode section is then applied to the control grid of output amplifier V307.

3-30. OUTPUT AMPLIFIER V307. Output amplifier V307 (see figures 3-2 and 5-3) is a conventional pentode video amplifier which is employed to amplify the modulation signal for application to the keyer amplifier (refer to paragraph 3-36).

3-31. PHASE INVERTER V305A. Phase inverter V305A (see figures 3-2 and 5-3) is provided to permit external synchronization or modulation of the MSG-1R/2R by either positive or negative signals applied to EXT SYNC/EXT MOD connector J107.

3-32. Phase inverter V305 passes the signal applied to the EXT SYNC/EXT MOD connector either with or without inversion, depending on the nature of the

applied signal. SYNC SELECTOR switch S300 selects a signal from the cathode of V305A when the applied voltage is a negative pulse or sinusoidal in nature, or selects a signal from the plate when the applied voltage is a positive pulse. Resistors R343 and R344 are chosen such that the gain at both the plate and cathode are equal. The output of V305A, which is always a negative pulse, is applied to output amplifier V307 when the MSG-1R/2R is programmed for external pulse modulation, or to clipper amplifier V305B when programmed for external synchronization.

3-33. CLIPPER AMPLIFIER V305B. Clipper amplifier V305B (see figures 3-2 and 5-3) amplifies and clips the output signal from phase inverter V305A for application to Schmitt trigger V306. V305B is biased through cathode resistor R349. The negative amplitude of the applied synchronizing signal is large enough to drive V305B beyond cutoff. The output clipping, therefore, is due to the cutoff action of V305B. The resulting positive output pulse is applied to the control grid of Schmitt trigger V306, which produces the trigger pulse that synchronizes the rate generator.

3-34. SCHMITT TRIGGER V306. Schmitt trigger V306 (see figures 3-2 and 5-3) is a conventional cathode-coupled binary which shapes and flattens the trigger pulse output of clipper amplifier V305B. The output of the trigger is taken at the plate (pin 9) and applied to the control grid of puller amplifier V303A when SYNC SELECTOR switch S300 is in the +EXT, -EXT, or SINE position, depending on the nature of the synchronizing signal.

3—35. DETAILED CIRCUIT ANALYSIS, TUNING UNITS.

3-36. The two tuning units available are identical in principles of operation. Differences exist, due to the frequency range of each tuning unit, in the type of reflex klystrons employed. In addition, to cover the Model MSG-1R Tuning Unit frequency range with adequate output power, mode switching is employed; the Model MSG-2R Tuning Unit does not require such mode switching. The reader should refer to the individual detailed schematic diagrams of the tuning units (figures 5-1 and 5-2) to note the actual circuit differences Because the Model MSG-1R Tuning Unit is of a more complex nature, paragraphs 3-38 through 3-51 describe this unit.

3-37. BEAM CURRENT REGULATOR V100 AND KEYER AMPLIFIER V101. The keyer circuitry, which consists of beam current regulator V100 and keyer amplifier V101 (see figures 3-2, 5-1, and 5-2), is actually a switch which determines the bias voltage applied to the control grid of r-f oscillator V13. When the MODULATION SELECTOR switch is in the +EXT MOD, -EXT MOD, INT SQ WAVE, ZERO SET, INT FM, or PULSE position, both sections of V101 have their cathodes tied together. In the absence of a modulating signal, the voltage at the plate (pin 9) is sufficient to bias the r-f oscillator so as to prevent oscillation. With a modulation pulse applied to the control grid (pin 7), the voltage at the plate (pin 9) rises, for the duration of the pulse, and permits the reflex klystron to sustain oscillations.

3-38. The bias voltage required for proper cw operation is determined by the setting of Beam Current Adj. control R211. This control determines the plate supply voltage to keyer amplifier V101, and hence the reflex klystron bias voltage.

3-39. R-F OSCILLATOR V13. R-f oscillator V13 (see figures 3-2, 5-1, and 5-2) is a reflex klystron tube operating in an external resonant cavity. The cavity is in the form of a coaxial transmission line, and consists of two cylinders - one inside the other. The reflex klystron tube is inserted at one end of the cavity so that the outer cylinder makes contact with the first interaction grid (so termed because it is closer to the cathode). The spring fingers of the inner cylinder makes contact with the second interaction grid. The circuit is completed at the other end of the cavity by a movable, non-contacting shorting plunger of special construction. The position of this movable short determines the physical wavelength, and hence the resonant frequency, of the cavity. The repeller voltage, which determines exact frequency of oscillation of the r-f oscillator, is tracked with the movement of the shorting plunger by the precision mechanical drive system (see paragraph 3-50). R-f power is extracted from the resonant cavity at two points: within the output attenuator waveguide-beyond-cutoff pipe and within the power set waveguide-beyond-cutoff pipe.

3-40. REPELLER VOLTAGE TRACKING. Since the operating frequency of the r-f oscillator is determined by both the physical wavelength of the external cavity and the magnitude of the repeller (repeller to cathode) voltage, the repeller voltage is simultaneously tracked with the position of the shorting plunger. The d-c voltage applied to the repeller is controlled by wire-wound potentiometer R96. The wiper arm of this potentiometer is mechanically coupledto the movable non-contacting shorting plunger located in the rf oscillator external resonant cavity.

3-41. For a given setting of the resonant cavity, there is an optimum repeller voltage required for oscillation. The repeller voltage, therefore, must vary if the operating frequency of the rf oscillator is to be changed. As the frequency increases, the magnitude of the repeller voltage must also increase (and vice versa) to maintain the maximum amplitude of oscillation. In the vicinity of 1,300 mc, the applied repeller voltage produces an output power that is excessively high. At this point it becomes advantageous to switch to the next higher mode of operation.

3-42. This is accomplished by mode switch S2 without changing the frequency of operation of the rf oscillator. The repeller voltage is reduced so that

the rf oscillator operates in the 2-3/4-wave repeller mode instead of the 1-3/4-wave mode. The 2-3/4-wave mode is maintained through the high end of the tuning range. Mode switch S2 is activated by a teflon cam mounted on the control shaft of repeller voltage tracking potentiometer R96.

3-43. Potentiometers R89, R90, R97, and R98, which are screwdriver adjusted, set the maximum and minimum voltages that can be applied to tracking potentiometer R96 in either mode of operation. Potentiometers R92, R93, R94, and R95, which are also screwdriver adjusted, permit fine adjustment of the repeller voltage for optimum tracking of the reflex klystron output.

3-44. POWER SET AND OUTPUT ATTENUATOR SYSTEM. The POWER SET and OUTPUT ATTENUATOR controls determine the positions of the thermistor probe assembly within the power set wave-guide-beyond-cutoff pipe and the output attenuator probe within the output attenuator waveguide-beyond-cutoff pipe, respectively. The POWER SET control simultaneously adjusts the position of the thermistor probe within the power set pipe and the position of the power set indicator hairline. The OUTPUT ATTENUATOR control, which functions independently of the POWER SET control, simultaneously adjusts the position of the output attenuator probe within its pipe and the position of the -DBM MICROVOLTS dial.

3-45. Rotation of the POWER SET control adjusts the position of the bead thermistor (refer to paragraph 3-46), and hence determines the amount of power absorbed by the probe. This control is adjusted until a POWER SET indication is obtained on the power monitor meter. When this adjustment has been made, the r-f power extracted by the output attenuator probe and coupled to the RF OUTPUT connector can be read directly from the -DBM MICROVOLTS dial with an accuracy of ± 2 db.

3-46. THERMISTOR BRIDGE CIRCUIT. The r-f power monitoring circuit consists of a Wheatstone-type bridge employing a variable resistance element (thermistor) as one of its arms. Changes in thermistor temperature (and hence resistance) are governed by three factors: thermal changes in its environment, the current flowing through it, and the r-f energy it absorbs. By compensating for two factors, namely the thermal change in its environment and the current passing through it, the thermistor can be used to measure r-f power by measuring the change in resistance caused by the r-f energy it has absorbed.

3-47. Two types of thermistors are employed in the bridge and associated compensating circuitry (see figures 5-1 and 5-2); the bead type (RT1) which has a small mass and is affected by all the factors mentioned above, and the disc type (RT2 and RT3) which has a relatively greater mass and is highly sensitive to its environmental temperature while being relatively insensitive to the current flowing through it. The basic bridge circuit, which consists of resistors R205, R206, and R207 and thermistor RT1 (which is part of the thermistor probe assembly located in the power set pipe), is balanced by adjusting ZERO SET control R100 when the MODULATION SELECTOR switch of the pulse modulator is in the ZERO SET position. After the power monitor meter has been zero-set, any of power fed into the power set pipe (when the MODULATION SELECTOR switch is set to any position other than ZERO SET) will be absorbed by the bead thermistor, thereby changing its resistance and unbalancing the bridge.

3-48. At any frequency, the greater the insertion of the thermistor probe within the power set pipe, the greater the power monitor meter pointer indication. When one milliwatt of r-f power is absorbed by the thermistor probe, the power monitor meter pointer will deflect to an indication of POWER SET. Disc thermistors RT2 and RT3, which are located on a thermistor mount attached to the power set pipe, are compensating devices. RT3, in combination with resistors R208 and R209, acts to correct any change in power monitor meter sensitivity caused by changes in ambient temperature. RT2, in combination with resistors R204 and R210, acts to correct any d-c unbalance caused by changes in ambient temperature.

3-49. PROTECTIVE DIODE CR101. Protective diode CR101 (see figures 5-1 and 5-2) is connected between the repeller and cathode of rf oscillator V13 to prevent possible damage to the reflex klystron should the repeller become positive with respect to the cathode. Since the cathode of CR101 is connected directly to the cathode of V13, and the anode of CR101 is connected directly to the repeller of V13, any circuit disturbance causing the repeller to become more positive than the cathode will drive CR101 into conduction. In this manner, the maximum possible positive voltage (with respect to the cathode) appearing at the repeller will be the small voltage drop appearing across the conducting protective diode.

3-50. PRECISION MECHANICAL DRIVE SYSTEM. The precision mechanical drive system (UNIDIAL®) simultaneously tracks the reflex klystron external resonant cavity, reflex klystron repeller voltage, and FREQUENCY KILOMEGACYCLES dial with rotation of the R. F. OSC. control. This drive system consists of a main drive shaft, and a precision gear assembly. Through this precision mechanical drive system, the rotational motion imparted to the R. F. OSC. control by the operator is converted to the translational motion required to track the external resonant cavity as well as the rotational motion necessary to drive the repeller voltage tracking potentiometer, the FREQUENCY KILOMEGACYCLES dial, and the mode switch cam.

3—51. DETAILED CIRCUIT ANALYSIS, MODEL GB-1 BASIC UNIT.

3-52. The voltages required for the operation of the equipment are obtained from the power supplies located in the Model GB-1 Basic Unit. The circuit analysis of this unit is described in paragraphs 3-53 through 3-56, and the functional block diagram is illustrated in figure 3-3.

3-53. -150-VOLT POWER SUPPLY. The -150-volt power supply (see figures 3-3 and 5-4) is a conventional series-type degenerative voltage regulator consisting of series regulator V1, d-c amplifier V2, and voltage regulator V3. The bias on the control grid (pin 7) of V2 is, by circuit design, the necessary value to obtain the desired -150-volt output across C5. Variations in output voltage due to fluctuations in either line voltage or load current, or both, are amplified by d-c amplifier V2. The voltage at the plate (pin 6) of V2 controls the grid bias of series regulator V1, causing the output voltage to return to the desired -150 volts.

3-54. The -150-volt supply, in conjunction with voltage regulator V3 and resistor R15, provides the necessary -108 volts required for the operation of the thermistor bridge circuitry.

3-55. -325-VOLT POWER SUPPLY. The -325-volt power supply (see figures 3-3 and 5-4) consists of a -175 volt supply in series with the -150 volt supply. This -175-volt supply is comprised of full-wave rectifier V4, series regulator V5, and d-c amplifier V6, and operates in much the same manner as does the -150 volt supply (refer to paragraph 3-53).

3-56. -700-VOLT POWER SUPPLY. The -700-volt power supply (see figures 3-3 and 5-4) consists of a -375-volt supply in series with both the -150 and -175 volt supplies. The -375-volt supply contains full-wave rectifier V7, series regulator V8, d-c amplifier V9, and voltage regulator V10. The operation is much the same as that for the -150-volt supply, except that the bias on the control grid of V9 is adjusted to obtain the proper output voltage by means of -700 V Adj control R39.

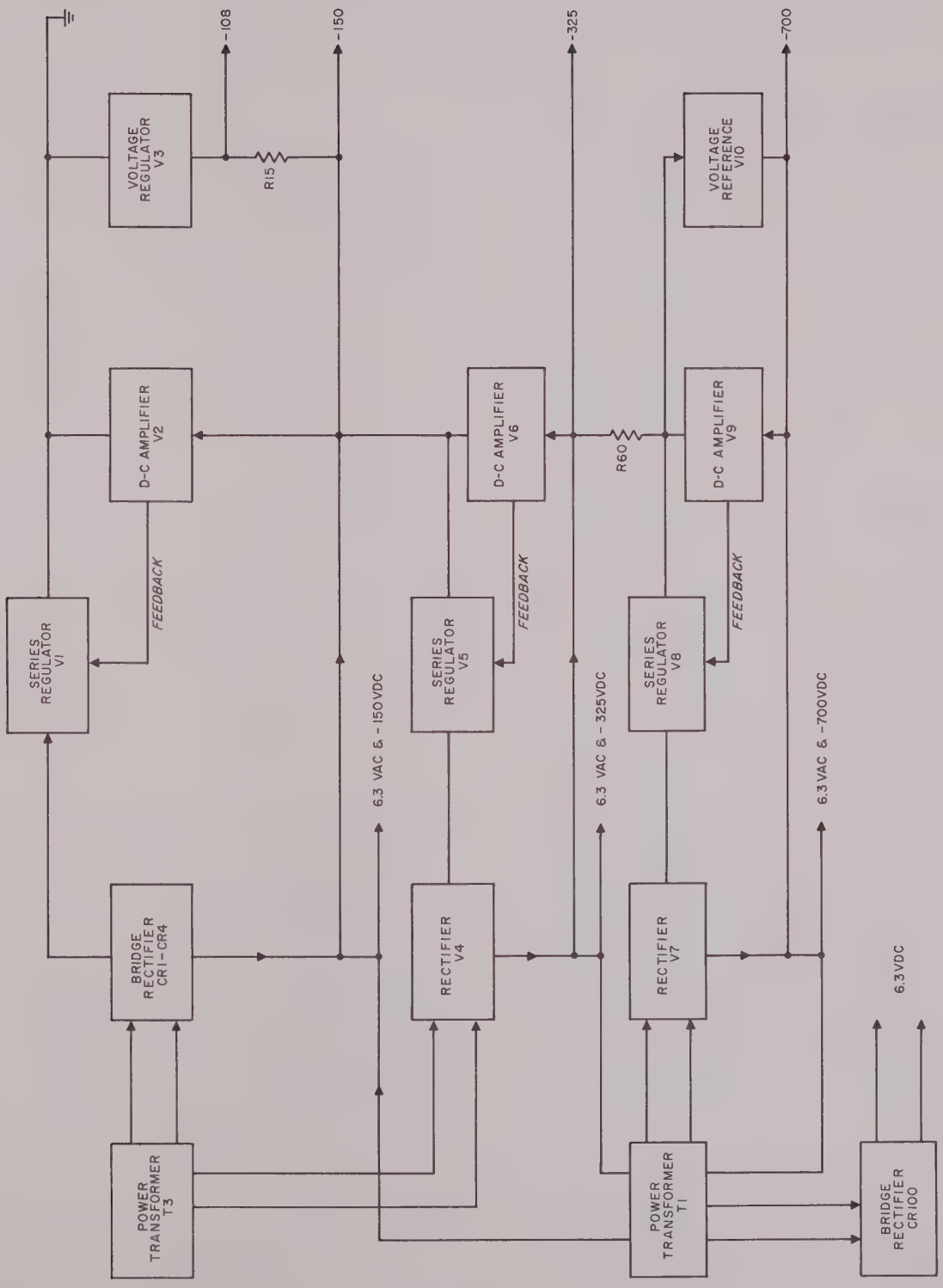


Figure 3-3. Model GB-1 Basic Unit, Detailed Block Diagram.

SECTION IV

MAINTENANCE

4—1. GENERAL.

4-2. This section contains maintenance and alignment procedures for the MSG-1R/2R. Included are a list of equipment required, troubleshooting procedures for localizing the source of equipment malfunction to an individual circuit, and the alignment procedures required to restore the MSG-1R/2R to original operating condition after the necessary repairs have been effected.

4—3. TEST EQUIPMENT REQUIRED.

4-4. The test equipment required for the maintenance and alignment of the MSG-1R/2R are listed in table 4-1.

4—5. PRELIMINARY INSPECTION.

4-6. Preliminary inspection is a series of visual and aural checks performed on the MSG-1R/2R system while it is in an unenergized state in an effort to correct conditions which might eventually cause system failure. In general, these failures will be caused by the overheating of electrical components, the accumulation of dust, dirt, and/or other foreign matter on moving parts, and loose connectors and hardware.

4-7. REMOVAL OF EQUIPMENT FROM DUST COVER. To remove the MSG-1R/2R from its dust cover, proceed as indicated in the following steps:

WARNING

OPERATION OF THE MSG-1R/2R INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. BE SURE TO REMOVE OPERATING POWER FROM THE BASIC UNIT BY DISCONNECTING THE 10-FOOT ELECTRICAL POWER CABLE ASSEMBLY FROM POWER INPUT 115/230V 50-60 CPS RECEPTACLE J1 BEFORE ATTEMPTING TO REMOVE THE EQUIPMENT FROM ITS DUST COVER.

a. Turn each of the four captive-lock fasteners (one located at each corner at the rear of the dust cover) one-quarter turn counterclockwise.

b. With two men working on the MSG-1R/2R (one on each side of the equipment), grasp the two tuning unit front panel handles and carefully slide the equipment from the dust cover.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Equipment, Model, and Manufacturer	Application
Simpson Model 260 Multimeter	Checking voltage, resistance, and current
Polarad Model MK-1 Klystron Mode Alignment Modulator	Tracking r-f oscillator repeller voltage
Tektronix Model 531 Oscilloscope	Observing waveforms
PRD Model 587A Frequency Meter	Checking output frequency
FXR Model N410A Frequency Meter	Checking output frequency
FXR Model H410A Frequency Meter	Checking output frequency
FXR Model H601B Waveguide-to-Coax Adapters	Checking output frequency
Dage Model 1021H Crystal Detector	Checking modulation characteristics
Electro-Pulse Model 3450C Pulse Generator	Checking modulation capabilities
Hewlett-Packard Model 202C Oscillator	Checking modulation capabilities
Polarad Model P-3 Microwave Power Meter	Checking r-f output power
Polarad Model TM-1 Thermistor Mount	Checking r-f output power

4-8. REMOVAL OF TUNING UNIT FROM BASIC UNIT. To remove the tuning unit from the basic unit, proceed as indicated in the following steps:

a. Disconnect P101 from J101.

b. Disconnect P102 from J102.

c. Turn each of the four captive-lock fasteners (one located at each corner of the tuning unit front panel) one-quarter turn counterclockwise.

d. Grasp the two tuning unit front panel handles and carefully slide the tuning unit from the basic unit.

4-9. With the equipment now visible and accessible, proceed as outlined in table 4-2 in an effort toward finding evidence of conditions which might cause system failure.

4—10. SYSTEM TROUBLESHOOTING.

4-11. The procedure for localizing the source of system malfunction is described in paragraphs 4-12 through 4-14.

4-12. TROUBLESHOOTING POWER SUPPLIES. Improper operation of the MSG-1R/2R may be caused by a malfunction within the power supplies located in the basic unit. Localization of the malfunction to an individual circuit component can be accomplished through the voltage and resistance measurements supplied in table 4-3, the component location diagram supplied in figure 4-1, and the schematic diagram of the basic unit supplied in figure 5-4.

Note

When making voltage and resistance measurements, make sure that all connectors are firmly secured to their mating receptacles.

4-13. If the power supplies are found to be operating properly, the malfunction lies within either the modulator unit or tuning unit. Refer to paragraph 4-14.

4-14. TROUBLESHOOTING MODULATOR UNIT AND TUNING UNIT. If the results of paragraph 4-12 indicated that the system malfunction lies within either the modulator unit or the tuning unit, proceed as indicated in table 4-4 to localize the trouble.

4—15. REPLACEMENT OF THERMISTOR PROBE.

4-16. To replace the thermistor probe, proceed as indicated in the following steps (see figure 4-11):

a. With operating power removed from the equipment, remove the tuning unit from the basic unit frame.

b. Unsolder the thermistor probe cable terminations on the terminal board assembly.

c. Loosen and remove the single cable clamp that secures the thermistor probe cable to the terminal board bracket.

d. Loosen the two setscrews (1, figure 4-11) that secure the thermistor probe drive yoke (3, figure 4-11) to the thermistor probe drive rod (5, figure 4-11).

e. Carefully withdraw the thermistor probe (2, figure 4-11) and thermistor probe drive yoke from the power set pipe (4, figure 4-11) and thermistor probe drive rod, respectively.

f. Gently separate the thermistor probe from the thermistor probe drive yoke.

g. Carefully mate the replacement thermistor probe with the thermistor probe drive yoke so that the scribed line on the barrel of the probe will face the reflex klystron protective shield when the probe is inserted into the power set pipe.

h. Carefully insert the tip of the replacement thermistor probe into the power set pipe.

i. Carefully slip the thermistor probe drive yoke over the thermistor probe drive rod.

j. Tighten the two setscrews on the thermistor probe drive yoke to secure it to the thermistor probe drive rod.

k. Clamp the thermistor probe cable to the terminal board bracket.

l. Proceed to paragraph 4-27.

4—17. REPLACEMENT OF THERMISTOR MOUNT.

4-18. To replace the thermistor mount, proceed as indicated in the following steps (see figure 4-11):

a. Remove the thermistor probe from the power set pipe (refer to paragraph 4-15, steps a through e).

b. Loosen and remove the single screw that secures the thermistor mount cover plate to the thermistor mount (6, figure 4-11).

c. Remove the thermistor mount cover plate.

d. Remove the tubular cover from the thermistor mount.

e. Loosen the two screws that secure the thermistor mount to the power set pipe (4, figure 4-11).

f. Remove the thermistor mount from the power set pipe.

g. Unsolder the thermistor mount leads from their terminations on the mount.

h. Slip the replacement thermistor mount on the power set pipe.

i. Tighten the two screws to secure the replacement thermistor mount to the power set pipe.

TABLE 4-2. PRELIMINARY INSPECTION PROCEDURE

WHAT TO INSPECT	DEFECTS TO LOOK FOR	REMEDIES	PRECAUTIONS
Cable Assemblies (including electrical power cable, r-f cables, and video cables)	Kinks, cuts, deterioration, and fraying of insulation	Replace defective cable assembly	
	Loose connectors	Resolder connector or replace cable assembly	
	Dirt, oil, grease, and corrosion	Clean with a cloth moistened with cleaning solvent	
Harnessed cable assemblies	Loose connectors	Resolder connector	
	Deteriorated and/or frayed leads	Replace lead and relace cable	
	Defective or poor lacing	Relace cable	
Knobs, screws, connectors, and handles	Looseness	Tighten	Tighten carefully. Screws tightened beyond the pressure for which they were designed can be damaged or broken
Front panel switches	Inability to change position	Replace and rewire switch	
	Looseness	Tighten mounting hardware	
	Bent or broken contacts	Straighten contacts with tweezer or replace and rewire switch	
Fuses	Dirty fuse clips	Clean with a cloth	
Frame assemblies and basic unit subassemblies	Dirt and rust	Remove with brush or low-pressure air	
	Oil and grease	Remove with a cloth moistened with cleaning solvent	

(Cont'd)

TABLE 4-2. PRELIMINARY INSPECTION PROCEDURE (cont'd).

WHAT TO INSPECT	DEFECTS TO LOOK FOR	REMEDIES	PRECAUTIONS
Mounting screws and clamps	Looseness	Tighten	Do NOT touch slotted shafts of variable resistors
Wiring	Loose wires	Resolder, recable, and reclamp	
	Frayed, worn, or missing insulation	Replace wire	
Solder joints	Corroded joints	Clean and resolder	
Terminal board assemblies	Loose mounting	Tighten mounting screws and nuts	
Resistors	Cracks, chips, discoloration, blistering, and other signs of overheating	Replace resistor	Overheating components are a sign of equipment malfunction. Refer to proper troubleshooting paragraph to localize malfunction
Capacitors	Leaks, bulges, and other signs of deterioration	Replace capacitor	See above
Front panel meters	Bent pointer	Replace meter	
	Cracked or broken meter cover	Replace cover	
Vacuum tubes (except for reflex klystrons)	Poor seating	Press tubes firmly into sockets	Never work on tubes immediately after shutting off power. Do not jiggle or partially remove tubes from sockets. Such movements tend to weaken tube pins and spread socket connectors. DO NOT CHECK REFLEX KLYSTRONS

(Cont'd)

TABLE 4-2. PRELIMINARY INSPECTION PROCEDURE (cont'd).

WHAT TO INSPECT	DEFECTS TO LOOK FOR	REMEDIES	PRECAUTIONS
Tube shields (except for reflex klystron protective shield)	Poor seating	Press into position	
	Missing shields	Replace	
Tube sockets	Cracked or chipped sockets	Replace and rewire	
	Looseness	Tighten mounting screws	
FREQUENCY KILOMEGACYCLES dial window	Cracked or broken	Replace (A temporary repair may be effected with transparent tape)	
-DBM MICROVOLTS dial window	Cracked or broken	See above	
Precision mechanical drive system	Catching or jamming when RF OSC control is rotated	Remove dust, dirt, and any foreign matter	Release LOCK control by turning it counterclockwise
	Broken gears	Replace	**CAUTION** DO NOT MOVE THE PRECISION MECHANICAL DRIVE SYSTEM BY ANY MEANS OTHER THAN THE TUNING CONTROL. DO NOT INTERFERE IN ANY WAY WITH THE OPERATION OF THE GEARS WHILE THE TUNING CONTROL IS BEING ROTATED. NEVER USE FORCE.
Thermistor probe and output attenuator probe drive system	Catching or jamming when either POWER SET or OUTPUT ATTENUATOR control is rotated	Remove dirt, dust, and any foreign matter	**CAUTION** DO NOT MOVE THE DRIVE SYSTEM BY ANY MEANS OTHER THAN THE FRONT PANEL CONTROLS. DO NOT INTERFERE WITH THE OPERATION OF THE GEARS WHEN THE CONTROLS ARE BEING ROTATED. NEVER USE FORCE.
	Broken gears	Replace	

TABLE 4-3. VOLTAGE AND RESISTANCE MEASUREMENTS, MODEL GB-1 BASIC UNIT

Socket	Tube Type	Pin Number 1	2	3	4	5	6	7	8	9	
XVI	6336A	-30	+155	+6.5	-30	+155	+6.5	FIL	FIL	X	Volts
		∞	—	47	∞	—	47	4K	4K	X	Ohms
XV2	12AX7	-36	-150	-150	FIL		-30	-140	-150	FIL	Volts
		95K	4K	20K	4K	4K	∞	1.3M	4K	4K	Ohms
XV3	OB2	0	-108	*	-108	0	*	-108	X	X	Volts
		0	4K	—	4K	0	—	4K	X	X	Ohms
XV4	5Y3GT	*	-3	*	420AC	*	420AC	*	-2.5	X	Volts
		—	—	—	250	—	250	—	—	X	Ohms
XV5	6080	-225	-3	-150	-225	-3	-150	FIL	FIL	X	Volts
		∞	—	4K	1.3M	—	4K	1M	1M	X	Ohms
XV6	12AX7	-215	-325	-485	FIL		-225	-325	-325	FIL	Volts
		100K	10K	30K	10K	10K	1.2M	750K	10K	10K	Ohms
XV7	5Y3GT	*	-115	*	835AC	*	835AC	*	-115	X	Volts
		—	30K	—	—	—	—	—	30K	X	Ohms
XV8	6AQ5	-325	-325	FIL	FIL	-115	-150	-325	X	X	Volts
		850K	10K	10K	10K	30K	130K	850K	X	X	Ohms
XV9	12AX7	-340	-555	-615	FIL		-340	-555	-615	FIL	Volts
		850K	300K	140K	—	—	850K	300K	140K	—	Ohms
XV10	5651	-620	-700	*	-700	-620	*	-700	X	X	Volts
		—	—	—	—	—	—	—	X	X	Ohms

Notes: 1. FIL = 6.3 vac between pins so marked.

2. Voltage readings taken with 20,000 ohm/volt vom between pin and chassis ground.

3. Resistance readings taken with electrical power cable assembly removed.

* No internal element terminated at this pin.

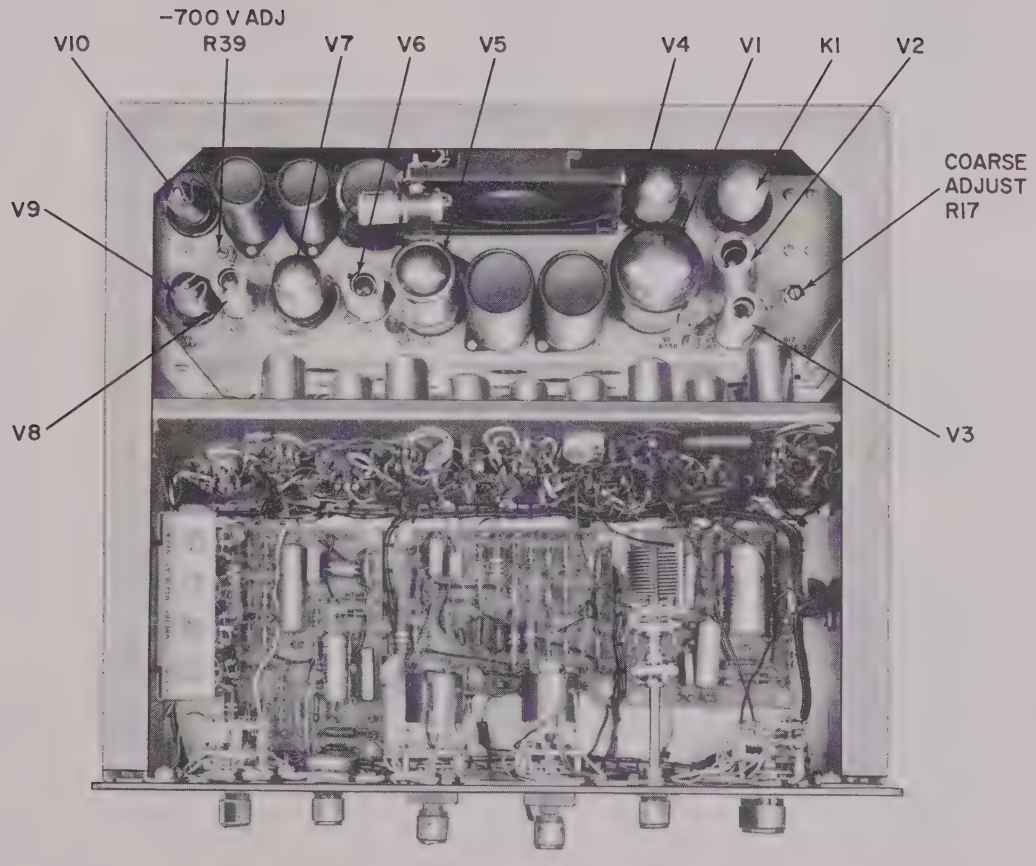


Figure 4-1. Component Location Diagram, Model GM-3 Pulse Modulator Unit Installed in Model GB-1 Basic Unit (Top View)

TABLE 4-4. MODULATOR UNIT AND TUNING UNIT TROUBLESHOOTING PROCEDURE

Step		Test Point	Instructions	Normal Indication	If Indication Is Abnormal	Remarks
Major	Minor					
1		Power monitor meter M100.	Set MODULATION SELECTOR switch S301 to ZERO SET. Adjust ZERO SET control R100 to obtain a power monitor meter pointer deflection of ZERO.	Power monitor meter pointer deflects to ZERO. Proceed to step 2.	Beam current regulator V100 and/or keyer amplifier V101 malfunctioning. Proceed to step 1a. Power set probe and/or thermistor bridge defective. Proceed to step 1b.	
	1a.	Grid test point TP1 and cathode test point TP3.	Measure the voltage between TP1 and TP3 with a 20,000 ohm/volt vom.	Voltage at TP1 is between -3 and -10 volts with respect to TP3. Proceed to step 1b.	Check V100, V101, and associated circuitry.	
	1b.	Thermistor probe cable.	De-energize equipment. Unsolder termination of thermistor probe cable from terminal board assembly. Measure d-c resistance of thermistor probe.	Ohmmeter indicates approximately 2,000 ohms. Proceed to step 1c.	Replace defective thermistor probe assembly. Refer to paragraph 4-15.	
	1c.	Thermistor bridge components.	Check thermistor bridge components.	————	Replace defective components where necessary. Refer to paragraph 4-17.	
2		Power monitor meter M100.	Set MODULATION SELECTOR switch S301 to CW. Adjust POWER SET control to obtain a power monitor meter pointer deflection of POWER SET.	Power monitor meter pointer deflects to POWER SET. Proceed to step 3.	R-f oscillator V13 defective and/or repeller voltage improperly tracked. Proceed to step 2a.	
	2a.	Rf oscillator V13.	De-energize equipment. Connect d-c milliammeter between terminal 3 of TB5 and blue cathode lead from r-f oscillator V13. Energize equipment and note current indication.	D-c milliammeter indicates 28 ma. Remove milliammeter and proceed to step 2b.	Adjust Beam Current Adj control R111 to obtain d-c milliammeter reading of 28 ma.	If proper beam current cannot be obtained, replace r-f oscillator V13 (refer to paragraph 4-19).

(Cont'd)

TABLE 4-4. MODULATOR UNIT AND TUNING UNIT TROUBLESHOOTING PROCEDURE (Cont'd).

Step		Test Point	Instructions	Normal Indication	If Indication Is Abnormal	Remarks
Major	Minor					
	2b	RF OUTPUT connector J110.	With equipment de-energized, measure d-c resistance between center conductor of RF OUTPUT connector and chassis ground with vom.	Ohmmeter indicates 50 ohms.	Output attenuator probe defective. Replace (refer to paragraph 4-21).	
3		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-2. Track the MSG-1R/2R, in 100-mc increments, from the low end of the band to the high end (refer to paragraph 2-13). At each point tune the frequency meter to obtain a dip in oscilloscope display.	Frequency meter reading is within ±1% of FREQUENCY KILOMEGACYCLES dial indication. Proceed to step 4.	Track reflex klystron repeller voltage. Refer to paragraph 4-23.	
4		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-3. Program MSG-1R/2R for internally synchronized square-wave modulated operation (refer to paragraph 2-14). Check repetition frequency of square-wave-modulated r-f output signal.	Repetition frequency of internally synchronized square-wave-modulated r-f output signal adjustable from 10 to 10,000 cps by means of RATE CYCLES/SECOND control R301 and RATE CYCLES/SECOND switch S302. Proceed to step 5.	Check V301, V302A, V302B, V307, and associated circuitry. Replace defective component (s) where necessary.	Refer to paragraph 4-29 to adjust the maximum repetition frequency. Refer to paragraph 4-31 to optimize the symmetry of the square-wave-modulated r-f output signal.
5		DELAYED SYNC connector J106.	Connect equipment as illustrated in figure 4-4. Program MSG-1R/2R for internally synchronized pulse-modulated operation (refer to paragraph 2-15) with PULSE WIDTH MICROSECONDS control set fully counterclockwise. Check delay of delayed sync output pulse.	Delay between start of oscilloscope trace and leading edge of delayed sync output pulse adjustable from 2 to 2,000 microseconds by means of DELAY MICROSECONDS control R367 and DELAY MICROSECONDS switch S303. Proceed to step 6.	Check V303A, V304A, V309, V308A, V308B, V303B, V304B, and associated circuitry. Replace defective component (s) where necessary.	Refer to paragraph 4-33 to adjust the maximum delay.

(Cont'd)

TABLE 4-4. MODULATOR UNIT AND TUNING UNIT TROUBLESHOOTING PROCEDURE (Cont'd).

Step		Test Point	Instructions	Normal Indication	If Indication Is Abnormal	Remarks
Major	Minor					
6		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-5. Program MSG-1R/2R for internally synchronized pulse-modulated operation (refer to paragraph 2-15) with DELAY MICROSECONDS control R367 and DELAY MICROSECONDS switch S303 adjusted for minimum delay. Check width of detected r-f output pulse.	Width of detected rf output pulse adjustable from 0.3 to 10 microseconds by means of PULSE WIDTH MICROSECONDS control C332. Proceed to step 7.	Check V310 and associated circuitry.	Refer to paragraph 4-35 to set maximum and minimum width of r-f output pulse.
7		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-2. Program MSG-1R/2R for internally synchronized frequency-modulated operation (refer to paragraph 2-18) with FM AMPLITUDE control R318 set fully clockwise. Check frequency excursion from end to end of detected frequency-modulated output (see figure 4-6).	Frequency deviation of modulated r-f output pulse at least ±2.5 mc of center frequency. Proceed to step 8.	Check V302A and associated circuitry.	
8		OUTPUT FM connector J109.	Connect equipment as illustrated in figure 4-7. Program MSG-1R/2R for internally synchronized frequency-modulated operation (refer to paragraph 2-18) with FM AMPLITUDE control set fully clockwise. Check for sawtooth signal at OUTPUT FM connector J109.	Sawtooth signal available at OUTPUT FM connector. Proceed to step 9.	Check S301A and associated circuitry.	

(Cont'd)

TABLE 4-4. MODULATOR UNIT AND TUNING UNIT TROUBLESHOOTING PROCEDURE (Cont'd).

Step		Test Point	Instructions	Normal Indication	If Indication Is Abnormal	Remarks
Major	Minor					
9		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-8. Program the MSG-1R/2R for external pulse-modulated operation (refer to paragraph 2-17). Adjust pulse width of external source from 0.3 to 50,000 microseconds and repetition rate from 10 to 10,000 pps. Check output r-f pulse characteristics.	R-f output pulses have same pulse width and repetition rate as modulating pulse.	Check V305A and associated circuitry.	
10		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-9. Program the MSG-1R/2R for externally synchronized pulse-modulated operation (refer to paragraph 2-16) with DELAY MICROSECONDS control R368 and DELAY MICROSECONDS switch S303 adjusted for minimum delay. Rotate PULSE WIDTH MICROSECONDS control fully clockwise. Check for pulse output as repetition rate of pulse generator is varied from 10 to 10,000 pps.	Output r-f pulse can be externally synchronized by signal having repetition rate from 10 to 10,000 pps. Proceed to step 11.	Check V305B, V306, and associated circuitry.	
11		RF OUTPUT connector J110.	Connect equipment as illustrated in figure 4-110. Program the MSG-1R/2R for external frequency-modulated operation (refer to paragraph 2-19). Adjust amplitude of external modulating signal from 0 to 50 volts and the repetition frequency from 100 to 100,000 cps. Check for frequency deviation.	Deviation of frequency-modulated r-f output signal adjustable from 0 to at least ±2.5 mc of center frequency.	Check EXT FM connector J108 and associated circuitry.	

NOTE:
PRD MODEL 587A FREQUENCY METER EMPLOYED OVER FREQUENCY RANGE FROM 0.95 TO 1.00GC.
FXR MODEL N410A FREQUENCY METER EMPLOYED OVER FREQUENCY RANGE FROM 1.00 TO 4.00GC.
FXR MODEL H410A FREQUENCY METER AND TWO (2) FXR MODEL H601B WAVEGUIDE – TO– COAX ADAPTERS EMPLOYED OVER FREQUENCY RANGE FROM 4.00 TO 4.60GC.

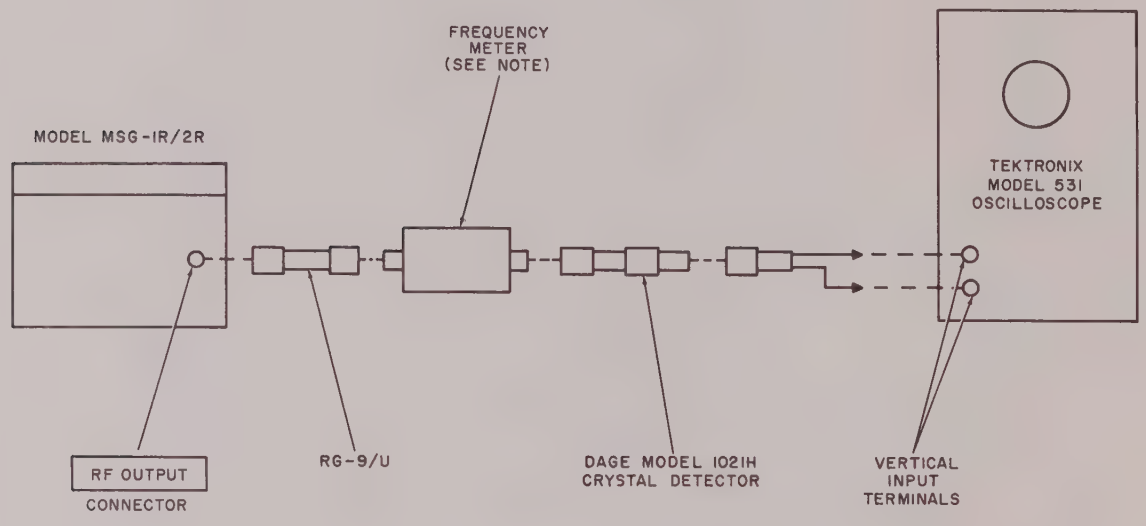


Figure 4-2. Checking CW Output, Equipment Setup

j. Replace the thermistor mount tubular cover.

k. Replace the thermistor mount cover plate.

l. Replace and tighten the single screw to secure the thermistor mount cover plate to the thermistor mount.

m. Solder the leads of the replacement thermistor mount to the appropriate terminations on the terminal board assembly.

n. Replace the thermistor probe into the power set pipe (refer to paragraph 4-15, steps h through j).

o. Proceed to paragraph 4-27.

4-19. REPLACEMENT OF KLYSTRON R-F OSCILLATOR V13.

4-20. The reflex klystron employed as the rf oscillator is partially seated within the right end of its external cavity (when viewed from the front of the tuning unit). The base of the tube, which protrudes from the cavity, is covered by a protective shield (see figure 4-12). If replacement of the reflex klystron is necessary, proceed as indicated in the following steps:

WARNING

BE SURE THAT THE EQUIPMENT HAS BEEN DE-ENERGIZED FOR A SUFFICIENT PERIOD OF TIME TO ALLOW THE REFLEX KLYSTRON TO COOL PRIOR TO HANDLING

a. Disconnect P101 (located in the basic unit) from J101 (located in the tuning unit).

b. Disconnect P102 (located in the modulator unit) from J102 (located in the tuning unit).

c. Remove the tuning unit from the basic unit.

d. Loosen the single clamp screw that secures the protective shield to the knurled retaining nut on the external cavity.

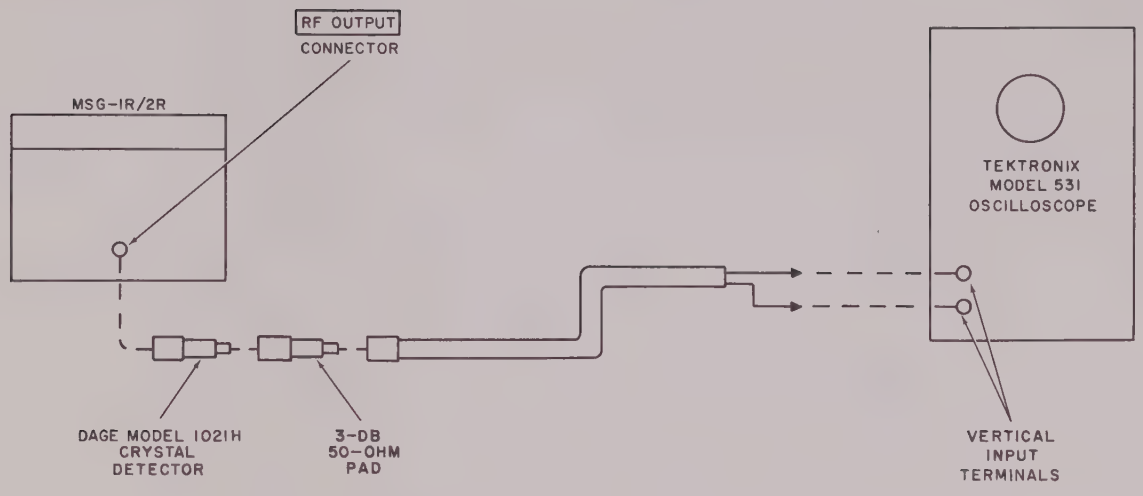


Figure 4-3. Checking Internally Synchronized Square-Wave-Modulated Output, Equipment Setup

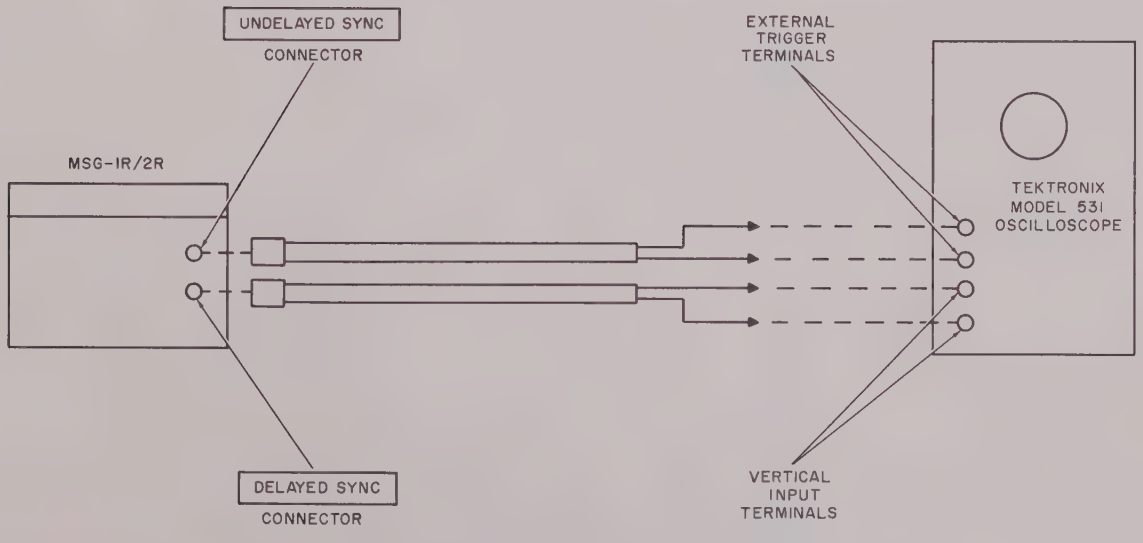


Figure 4-4. Checking Output Synchronizing Pulses, Equipment Setup

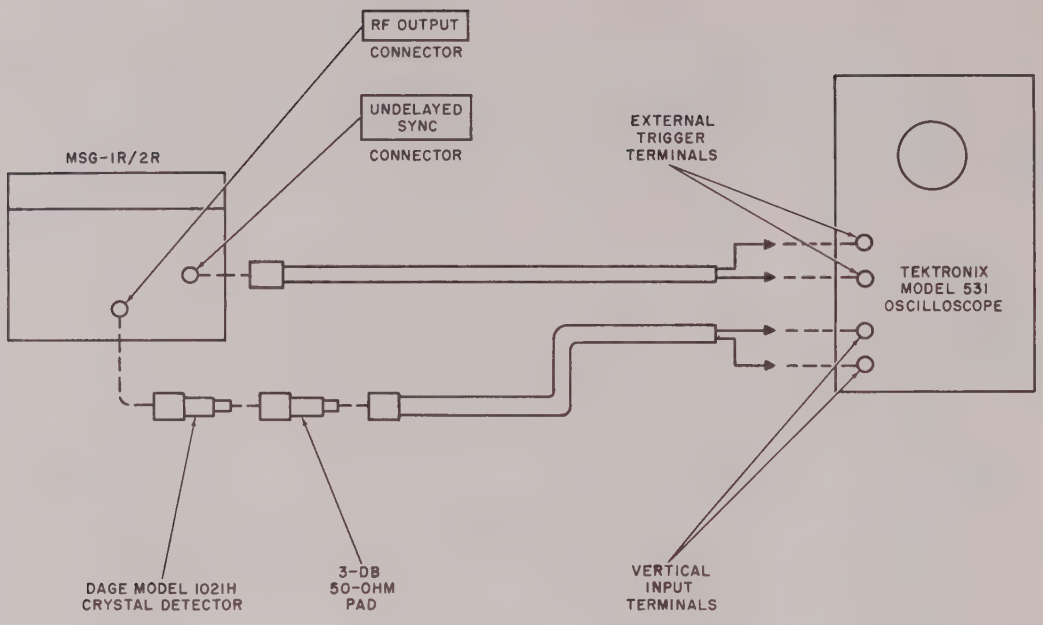
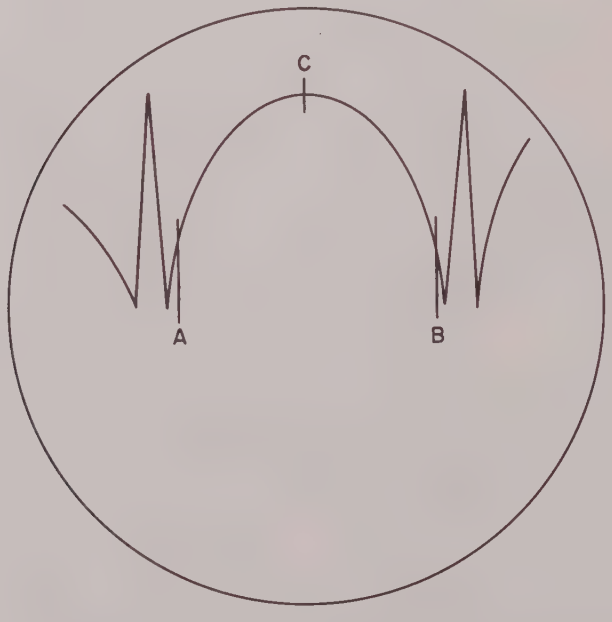


Figure 4-5. Checking Internally Synchronized Pulse-Modulated Output, Equipment Setup



Tune frequency meter to position dip at point A. Note frequency meter indication. Repeat for points B and C. Frequency difference between points A and C and between points B and C should each be equal to or greater than 2.5 mc.

Figure 4-6. Typical Oscilloscope Display of Internally Synchronized Frequency-Modulated Output

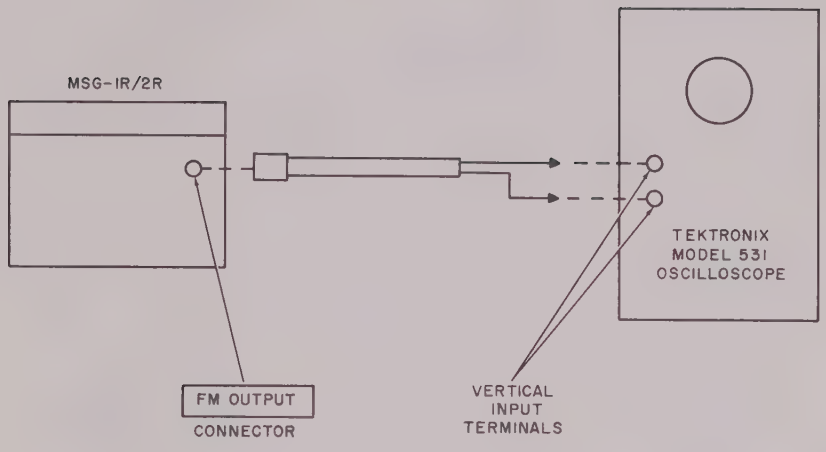


Figure 4-7. Checking Sawtooth Modulating Signal Output, Equipment Setup

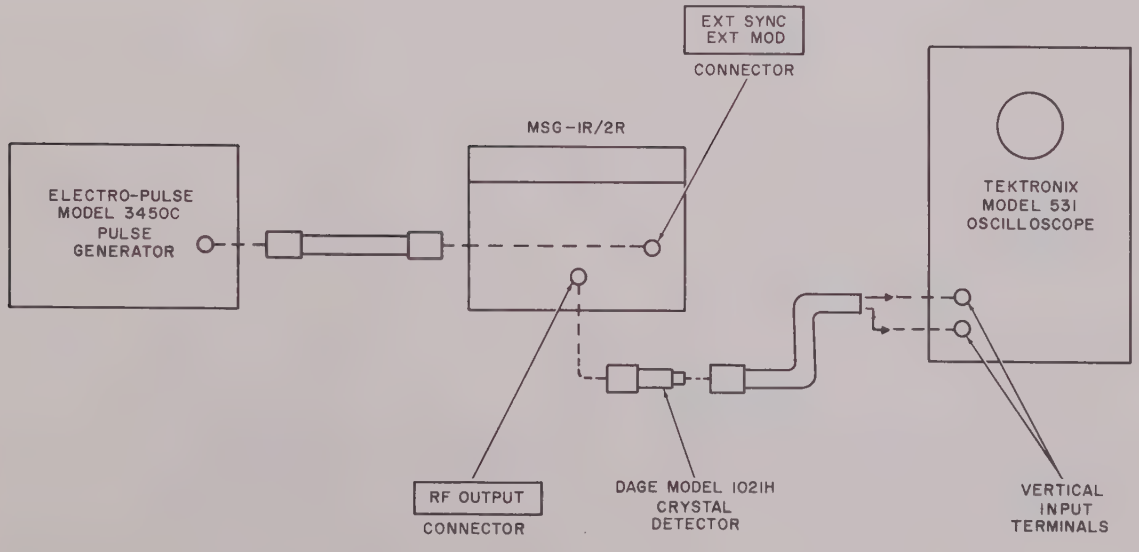


Figure 4-8. Checking External Pulse-Modulated Output, Equipment Setup

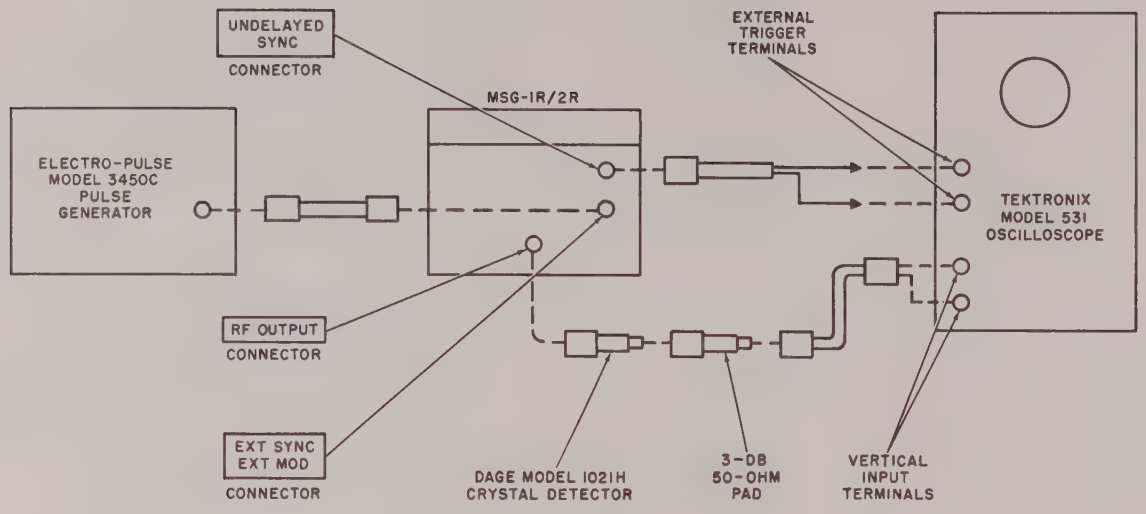


Figure 4-9. Checking Externally Synchronized Pulse-Modulated Output, Equipment Setup

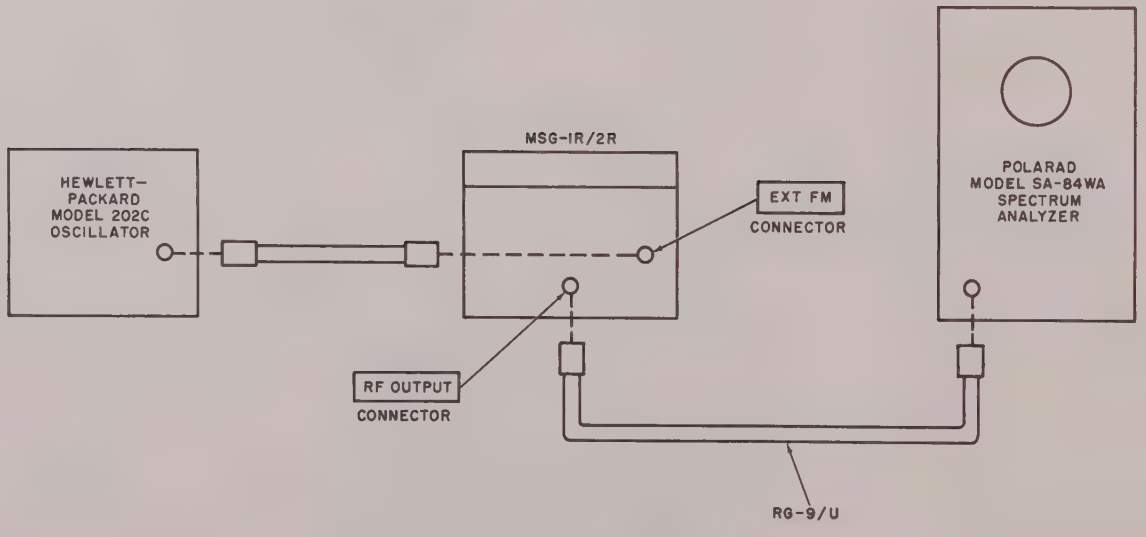
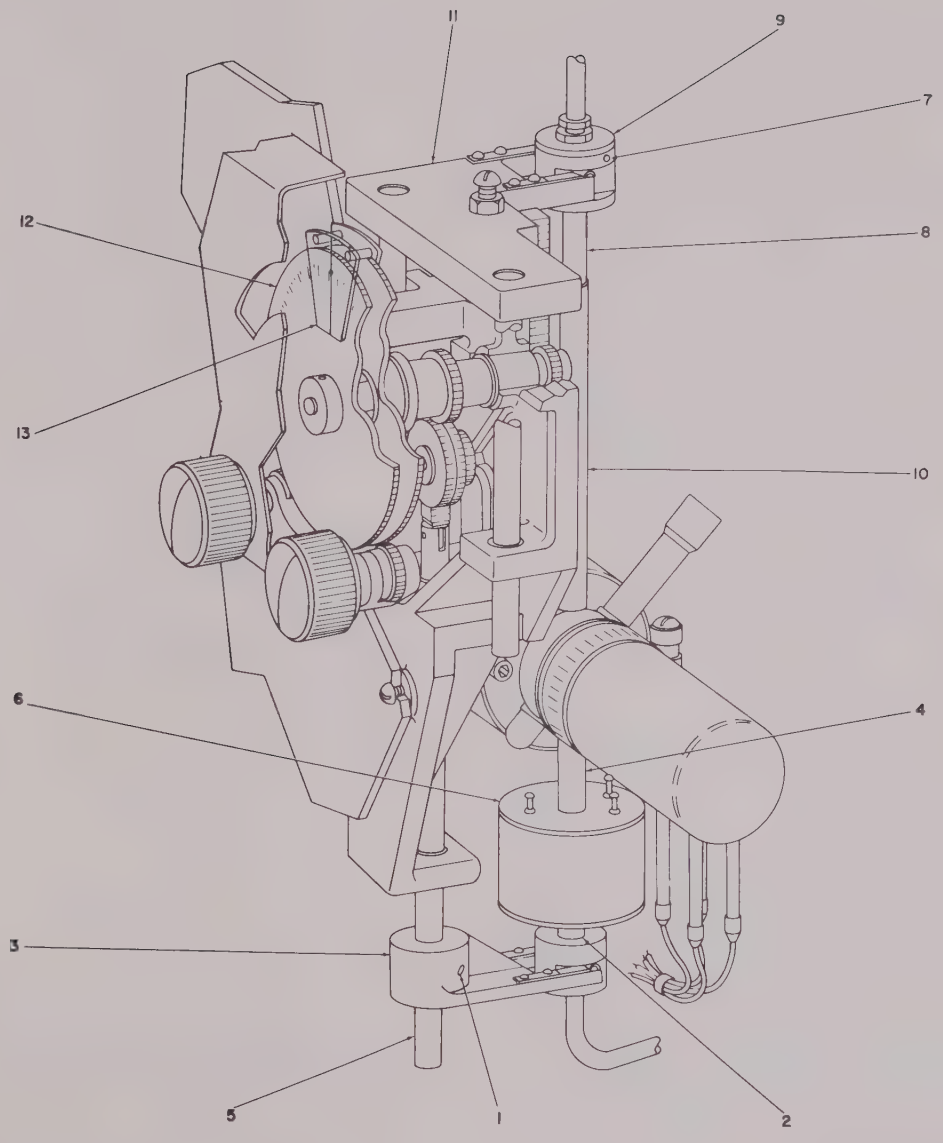


Figure 4-10. Checking External Frequency-Modulated Output, Equipment Setup



1. Setscrew
2. Thermistor probe
3. Thermistor probe drive yoke
4. Power set pipe
5. Thermistor probe drive rod
6. Thermistor mount
7. Setscrew
8. Output attenuator probe
9. Output attenuator collar
10. Output attenuator pipe
11. Output attenuator drive yoke
12. -DBM MICROVOLTS dial
13. Power set indicator

Figure 4-11. Power Set and Output Attenuator Drive Mechanism

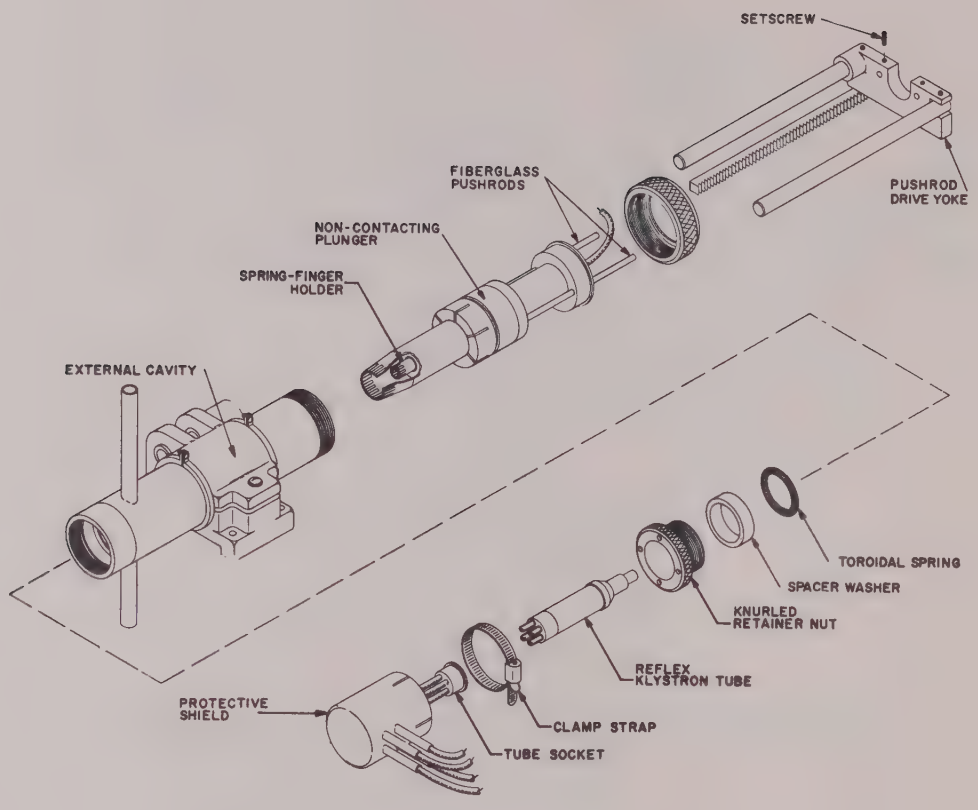


Figure 4-12. Klystron R-f Oscillator Assembly, Exploded View

e. Carefully remove the protective shield. The knurled retaining nut, tube socket, and protruding base of the reflex klystron will now be visible and accessible.

f. Carefully remove the tube socket from the base pins of the reflex klystron.

g. Adjust the arms of the spanner wrench (supplied) so that the pins engage the holes on the face of the knurled retainer nut.

h. Gently, but with pressure if necessary, rotate the spanner wrench counterclockwise (as viewed from the knurled retainer nut end of the cavity) to loosen the knurled retainer nut.

i. Remove the spanner wrench.

j. Rotate the knurled retainer nut by hand and remove it from the end of the external cavity. The protruding base of the reflex klystron tube can now be easily gripped.

k. Grasp the protruding base of the reflex klystron tube and, with a clockwise twisting motion, carefully withdraw it from the external cavity.

Note

Should the toroidal spring and/or spacer washer, which are both contained within the external cavity, come out as the reflex klystron tube is withdrawn, be sure to re-insert them before inserting the replacement reflex klystron tube. The toroidal spring is to be inserted first, followed by the spacer washer.

l. Carefully insert a replacement reflex klystron into the external cavity, applying a clockwise twisting motion to the tube as it enters the cavity. A slight but noticeable resistance will be felt as the reflex klystron contact ring engages the toroidal spring. Continue twisting the tube, while simultaneously pressing it further into the cavity, until a positive stop is obtained. At this point the tube is properly seated within the cavity.

m. Replace the knurled retainer nut on the end of the cavity and hand-tighten the nut.

n. Place the spanner wrench over the knurled retainer nut and rotate the wrench clockwise to firmly tighten the nut.

o. Remove the spanner wrench.

CAUTION

NEVER USE FORCE WHEN MATING THE KLYSTRON SOCKET TO THE BASE PINS OF THE REFLEX KLYSTRON TUBE. AS IT IS POSSIBLE TO MATE THE TWO IN A MISALIGNED POSITION, FORCED MATING WILL RESULT IN PERMANENT DAMAGE TO THE REFLEX KLYSTRON TUBE UPON APPLICATION OF OPERATING POWER. OBSERVE THE MARKINGS ON BOTH THE BASE OF THE REFLEX KLYSTRON TUBE AND THE KLYSTRON SOCKET WHEN MATING THE TWO.

p. Mate the klystron socket to the base pins of the reflex klystron tube.

q. Replace the protective shield over the protruding portion of the replacement reflex klystron so that the open end of the shield engages the knurled retainer nut.

r. Tighten the single clamp screw to secure the protective shield to the knurled retainer nut.

s. Rotate Beam Current Adj. control R211 fully counterclockwise.

t. Proceed to paragraph 4-23.

4—21. REPLACEMENT OF OUTPUT ATTENUATOR PROBE.

4-22. To replace the output attenuator probe, proceed as indicated in the following steps (see figure 4-11).

a. Rotate the OUTPUT ATTENUATOR control fully counterclockwise.

b. Loosen and remove the four screws that secure RF OUTPUT connector J110 to the tuning unit front panel.

c. Remove the RF OUTPUT connector from its mounting hole.

d. Loosen the two setscrews (7, figure 4-11) that secure the output attenuator probe (8, figure 4-11) to the output attenuator collar (9, figure 4-11).

e. Grasp the coaxial cable connecting the output attenuator probe to the RF OUTPUT connector and carefully remove the output attenuator probe from both the output attenuator pipe (10, figure 4-11) and the output attenuator collar.

f. Grasp the output attenuator collar and carefully remove it from its slotted mounting on the output attenuator drive yoke (11, figure 4-11).

g. Insert a replacement output attenuator probe into its slotted mounting on the output attenuator drive yoke. Be sure to orient the former so that its setscrews are located above the uppermost surface of the latter.

h. Insert the replacement output attenuator probe through the output attenuator probe yoke and into the output attenuator pipe.

i. Adjust the position of the output attenuator probe so that:

1. The end of the output attenuator probe barrel is flush with the top surface of the output attenuator probe yoke, and

2. The scribed line on the barrel of the thermistor probe faces the reflex klystron protective shield.

j. Tighten the two setscrews to secure the output attenuator probe to the output attenuator probe yoke.

k. Proceed to paragraph 4-27.

4—23. TRACKING REFLEX KLYSTRON REPELLER VOLTAGE.

4-24. Due to variations in reflex klystron tube characteristics, replacement of r-f oscillator V13 will necessitate retracking of the reflex klystron repeller voltage. The procedure for tracking the repeller voltage for the Model MSG-1R Tuning Unit (which employs mode switching) is described in paragraph 4-25; that for the Model MSG-2R Tuning Unit (which does not employ mode switching) is described in paragraph 4-26.

4-25. MODEL MSG-1R TUNING UNIT. To retrack the repeller voltage of the Model MSG-1R Tuning Unit reflex klystron, proceed as indicated in the following steps:

a. With the tuning unit installed in the basic unit, and with operating power removed from the equipment, connect the common probe of a Simpson Model 260 Multimeter (used as a milliammeter) to connector 3 of TB5. Connect the blue reflex klystron cathode lead to the common probe.

b. Connect the positive probe of a second Simpson Model 260 Multimeter to chassis ground. Connect the common probe to pin 9 of T1.

c. Set MODULATION SELECTOR switch S301 to CW.

d. Energize the equipment and allow a 15-minute warm-up.

e. Adjust -700V Adj. control R39, if necessary, to obtain a voltmeter indication corresponding to exactly -700 volts.

f. Adjust Beam Current Adj. control R211 to obtain a milliammeter indication of 28 milliamperes.

g. De-energize and disconnect the equipment.

h. Remove the tuning unit from the basic unit and connect the positive probe of a Simpson Model 260 Multimeter to Refl. test point TP2. Connect the common probe to Cath. test point TP3, and set the multimeter for negative voltages.

i. Adjust the tracking potentiometers (R89, R90, R92 through R94, R97, and R98) to obtain the voltages indicated in table 4-5.

Note

The tracking potentiometers should be adjusted in the sequence indicated in table 4-5. The adjustments will have to be repeated several times to obtain the correct voltages due to the interaction between the controls. Always adjust the potentiometers in the same order, starting at the low-frequency end of the band and going completely through the band to the high-frequency end.

j. De-energize and disconnect the equipment.

k. Connect the equipment as illustrated in figure 4-13.

l. Adjust the RF OSC control to obtain a FREQUENCY KILOMEGACYCLES dial indication at the low end of the band.

m. Rotate the RF OSC control to a point just before mode switching (corresponding to a FREQUENCY KILOMEGACYCLES dial indication of approximately 1.30 kmc).

n. Energize the equipment and allow a 10-minute warm-up.

o. Set the MODULATION SELECTOR switch to EXT FM.

p. Adjust the OUTPUT ATTENUATOR control to obtain an oscilloscope display of convenient amplitude.

q. Adjust the "amp" control of the Model MK-1 Klystron Mode Alignment Modulator to obtain a trace of the mode pattern on the oscilloscope display. (See figure 4-14a.)

r. Adjust the "phase" control of the Model MK-1 Klystron Mode Alignment Modulator to reduce the two traces that appear on the oscilloscope display to a single trace. (See figure 4-14b.)

s. Center the mode on the oscilloscope display. (See figure 4-14c.)

t. Tune the frequency meter to the frequency indicated on the FREQUENCY KILOMEGACYLES dial. Note the oscilloscope display. The "suck-out" dip should occur at the peak of the displayed mode pattern (see figure 4-14d). If it does not, carefully loosen the two setscrews that secure the two white fiberglass pushrods (see figure 4-12) to the pushrod drive yoke. Carefully adjust the insertion of the pushrods to position the "suck-out" dip at the peak of the displayed mode, and then tighten the setscrews.

TABLE 4-5. TRACKING POTENTIOMETER ADJUSTMENT SEQUENCE, MODEL MSG-1R TUNING UNIT.

Step	FREQUENCY KILOMEGACYCLES Dial Indication	Repeller-to-Cathode Voltage	Adjust Tracking Potentiometer
1	0.95	-70 Volts	Low, R90
2	1.05	-85 Volts	Track 1, R95
3	1.20	-135 Volts	Track 2, R94
4	1.29	-160 Volts	Low Mode, R97
5	1.31	-55 Volts	High Mode, R98
6	1.60	-85 Volts	Track 3, R93
7	1.90	-155 Volts	Track 4, R92
8	2.40	-260 Volts	High, R89

TABLE 4-6. TRACKING POTENTIOMETER ADJUSTMENT SEQUENCE, MODEL MSG-2R TUNING UNIT

Step	FREQUENCY KILO-MEGACYCLES Dial Indication	Repeller-to-cathode Voltage	Adjust Tracking Potentiometer
1	2.00	-35 Volts	Low, R90
2	2.30	-60 Volts	Track 1, R95
3	2.65	-80 Volts	Track 2, R94
4	3.10	-135 Volts	Track 3, R93
5	3.80	-220 Volts	Track 4, R92
6	4.60	-330 Volts	High, R89

NOTE:
PRD MODEL 587A FREQUENCY METER EMPLOYED OVER THE FREQUENCY RANGE FROM 0.95 TO 1.00 GC.
FXR MODEL N410A FREQUENCY METER EMPLOYED OVER THE FREQUENCY RANGE FROM 1.00 TO 2.40 GC.

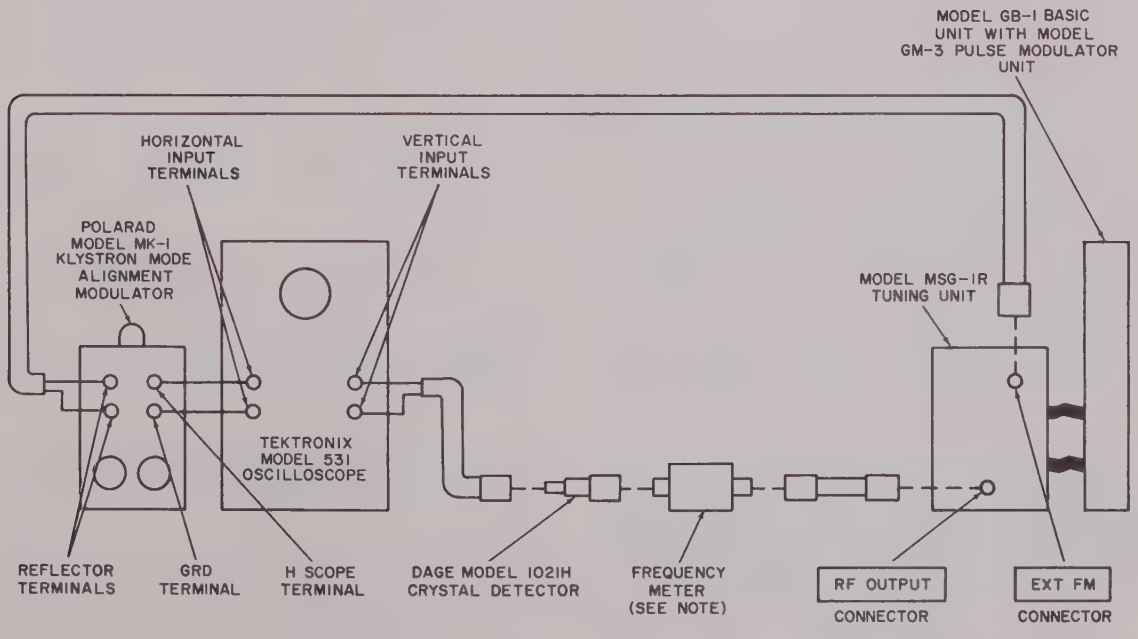

MODEL GB-1 BASIC UNIT WITH MODEL GM-3 PULSE MODULATOR UNIT
HORIZONTAL INPUT TERMINALS
VERTICAL INPUT TERMINALS
POLARAD MODEL MK-1 KLYSTRON MODE ALIGNMENT MODULATOR
MODEL MSG-1R TUNING UNIT
TEKTRONIX MODEL 531 OSCILLOSCOPE
REFLECTOR TERMINALS
GRD TERMINAL
H SCOPE TERMINAL
DAGE MODEL 1021H CRYSTAL DETECTOR
FREQUENCY METER (SEE NOTE)
RF OUTPUT CONNECTOR
EXT FM CONNECTOR

Figure 4-13. Tracking Repeller Voltage of Model MSG-1R Tuning Unit, Equipment Setup

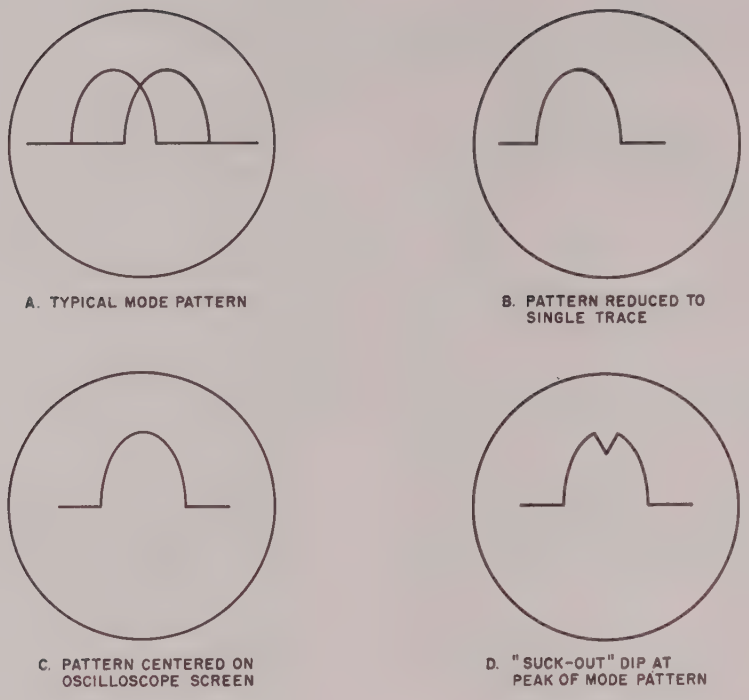

A. TYPICAL MODE PATTERN
B. PATTERN REDUCED TO SINGLE TRACE
C. PATTERN CENTERED ON OSCILLOSCOPE SCREEN
D. "SUCK-OUT" DIP AT PEAK OF MODE PATTERN

Figure 4-14. Typical Oscilloscope Mode Pattern Displays

CAUTION

APPLICATION OF TOO GREAT A MODULATING VOLTAGE TO THE EXT FM CONNECTOR (WHEN THE MSG-1R IS PROGRAMMED FOR EXTERNAL FREQUENCY-MODULATED OPERATION WITH THE MODEL MSG-1R TUNING UNIT TUNED TO THE LOW END OF THE BAND) CAN RESULT IN THE REPELLER DRAWING CURRENT. BE SURE TO REDUCE THE AMPLITUDE OF THE MODULATING SIGNAL WHEN OPERATING IN THIS REGION OF THE BAND.

u. Rotate the RF OSC control throughout the band and note the displayed mode pattern. It should remain centered on the oscilloscope screen.

v. Set the RF OSC control to each of the frequencies listed in table 4-5. At each frequency, tune the frequency meter to position the "suck-out" dip at the peak of the displayed mode. Note the frequency meter indication at each test frequency. The FREQUENCY KILOMEGACYCLES dial indication should be within ±1% of the frequency meter indication.

w. Disconnect the equipment and reconnect as illustrated in figure 4-5.

x. Program the MSG-1R for internally synchronized pulse-modulated operation. The detected pulse viewed on the oscilloscope display should be free of jitter and have very little overshoot and slant. If these characteristics are pronounced, the repeller voltage must be retracked.

y. De-energize and disconnect the equipment.

4-26. MODEL MSG-2R TUNING UNIT. To retrack the repeller voltage of the Model MSG-2R Tuning Unit reflex klystron, proceed as indicated in the following steps:

a. With the tuning unit installed in the basic unit, and with operating power removed from the equipment, connect the common probe of a Simpson Model 260 Multimeter (used as a milliammeter) to connector 3 of TB5. Connect the blue reflex klystron cathode lead to the positive probe.

b. Connect the positive probe of a second Simpson Model 260 Multimeter to chassis ground. Connect the common probe of the multimeter to pin 9 of T1.

c. Set MODULATION SELECTOR switch S301 to CW.

d. Energize the equipment and allow a 15-minute warm-up.

e. Adjust -700V Adj. control R39, if necessary to obtain a differential voltmeter indication corresponding to exactly -700 volts.

NOTE:

FXR MODEL N410A FREQUENCY METER EMPLOYED OVER THE FREQUENCY RANGE FROM 2.00 TO 4.00 KMC.
FXR MODEL H410A FREQUENCY METER AND TWO (2) FXR MODEL H601B WAVEGUIDE-TO-COAX ADAPTERS EMPLOYED OVER THE FREQUENCY RANGE FROM 4.00 TO 4.60 KMC.

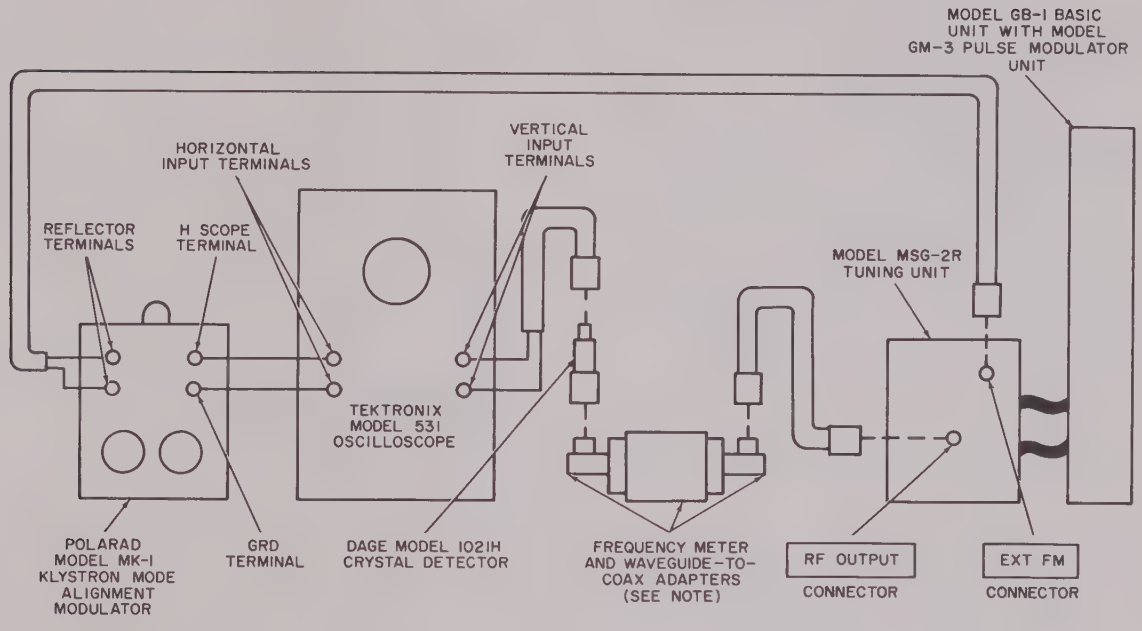


Figure 4-15. Tracking Repeller Voltage of Model MSG-2R Tuning Unit, Equipment Setup

f. Adjust Beam Current Adj. control R211 to obtain a milliammeter indication of 28 milliamperes.

g. De-energize and disconnect the equipment.

h. Remove the tuning unit from the basic unit and connect the positive probe of a Simpson Model 260 Multimeter to Refl. test point TP2. Connect the common probe to Cath. test point TP3, and set the multimeter for negative voltages.

i. Adjust the tracking potentiometers (R89, R90, and R92 through R95) to obtain the voltages indicated in table 4-6.

Note

The tracking potentiometers should be adjusted in the sequence indicated in table 4-6. The adjustments will have to be repeated several times to obtain the correct values due to the interaction between controls. Always adjust the potentiometers in the same order, starting at the low-frequency end of the band and going completely through the band to the high-frequency end.

j. De-energize and disconnect the equipment.

k. Connect the equipment as illustrated in figure 4-15.

l. Adjust the RF OSC control to obtain a FREQUENCY KILOMEGACYCLES dial indication of 3.30 kmc.

m. Energize the equipment and allow a 10-minute warm-up.

n. Set the MODULATION SELECTOR switch to EXT FM.

o. Adjust the OUTPUT ATTENUATOR control to obtain an oscilloscope display of convenient amplitude.

p. Adjust the "amp" control of the Model MK-1 Klystron Mode Alignment Modulator to obtain a mode pattern on the oscilloscope display. (See figure 4-14a).

q. Adjust the "phase" control of the Model MK-1 Klystron Mode Alignment Modulator to reduce the two traces that appear on the oscilloscope display to a single trace. (See figure 4-14b).

r. Center the mode pattern on the oscilloscope display. (See figure 4-14c).

s. Tune the frequency meter to the frequency indicated on the FREQUENCY KILOMEGACYCLES dial. Note the oscilloscope display. The "suck-out" dip should occur at the peak of the displayed mode pattern (see figure 4-14d). If it does not, carefully loosen the two setscrews that secure the two white fiberglass pushrods (see figure 4-12) to the pushrod drive yoke. Carefully adjust the insertion of the pushrods to position the "suck-out" dip at the peak of the displayed mode, and then tighten the setscrews.

CAUTION

APPLICATION OF TOO GREAT A MODULATING VOLTAGE TO THE EXT FM CONNECTOR (WHEN THE MSG-2R IS PROGRAMMED FOR EXTERNAL FREQUENCY-MODULATED OPERATION WITH THE MODEL MSG-2R TUNING UNIT TUNED TO THE LOW END OF THE BAND) CAN RESULT IN THE REPELLER DRAWING CURRENT. BE SURE TO REDUCE THE AMPLITUDE OF THE MODULATING SIGNAL WHEN OPERATING IN THIS REGION OF THE BAND.

t. Rotate the RF OSC control throughout the band and note the displayed mode pattern. It should remain centered on the oscilloscope screen.

u. Set the RF OSC control to each of the frequencies listed in table 4-6. At each frequency, tune the frequency meter to position the "suck-out" dip at the peak of the displayed mode. Note the frequency meter indication at each test frequency. The FREQUENCY KILOMEGACYCLES dial indication should be within ±1% of the frequency meter indication.

v. Disconnect the equipment and reconnect as illustrated in figure 4-5.

w. Program the MSG-2R for internally synchronized pulse-modulated operation. The detected pulse viewed on the oscilloscope display should be free of jitter, and have very little overshoot and slant. If these characteristics are pronounced, the repeller voltage must be retracked.

x. De-energize and disconnect the equipment.

4—27. CALIBRATING POWER OUTPUT

4-28. Replacement of the output attenuator probe, thermistor probe, or thermistor mount will necessitate calibration of the rf output power. The procedure for calibrating the output power is indicated in the following steps.

a. With the tuning unit removed from the basic unit, place the former on its back (front panel facing up) at the right-hand side of the latter (when viewed from the front panel of the basic unit).

b. Set the POWER ON switch to "off".

c. Connect P101 (located in the basic unit) to J101 (located in the tuning unit).

d. Connect P102 (located in the modulator unit) to J102 (located in the tuning unit).

e. Apply operating power to the equipment.

f. Set the POWER ON switch to "on". Allow the equipment to warm up for at least 15 minutes.

g. Set the MODULATION SELECTOR switch to ZERO SET.

h. Rotate the ZERO SET control fully clockwise.

i. Adjust Coarse Adjust control R17 to obtain a power monitor meter pointer deflection of full scale.

j. Adjust the ZERO SET control to obtain a power monitor meter pointer deflection of ZERO.

k. Rotate the RF OSC control to obtain a FREQUENCY KILOMEGACYCLES dial indication at the low end of the band.

l. Connect a microwave power meter and thermistor mount (such as the Polarad Model P-3 Microwave Power Meter and Model TM-1 Thermistor Mount, respectively) to the RF OUTPUT connector.

m. Set the MODULATION SELECTOR switch to CW.

n. Rotate the POWER SET control fully clockwise.

o. Loosen the two setscrews (1, figure 4-11) that secure the thermistor probe (2, figure 4-11) to the thermistor probe drive yoke (3, figure 4-11).

CAUTION

WHEN ADJUSTING THE POSITION OF THE THERMISTOR PROBE WITHIN THE POWER SET WAVEGUIDE-BEYOND-CUTOFF PIPE ON THE MODEL MSG-1R TUNING UNIT, EXERCISE CARE SO AS NOT TO DAMAGE THE "HAT" THAT IS LOCATED WITHIN THE EXTERNAL CAVITY. SHOULD THIS "HAT" BE BENT OR DAMAGED IN ANY WAY, BOTH THE FREQUENCY AND POWER OUTPUT CALIBRATION OF THE OSCILLATOR WILL BE VOID.

p. Carefully adjust the insertion of the thermistor probe within the power set waveguide-beyond-cutoff pipe (4, figure 4-11) so that the power monitor meter pointer deflects to an indication of at least 80% of full-scale.

q. Tighten the two setscrews (1, figure 4-11) to secure the thermistor probe to the thermistor probe drive yoke.

r. Adjust the POWER SET control to obtain a power monitor meter pointer deflection of POWER SET.

s. Rotate the RF OSC control to obtain various indications on the FREQUENCY KILOMEGACYCLES dial. At each indication, adjust the POWER SET control to ascertain that power monitor meter pointer deflections both above and below the POWER SET point can be obtained.

t. Rotate the RF OSC control to obtain a FREQUENCY KILOMEGACYCLES dial indication at the low end of the band.

u. Adjust the POWER SET control to obtain a power monitor meter pointer deflection of POWER SET.

v. Adjust the OUTPUT ATTENUATOR control to position the 0 dbm mark of the -DBM MICROVOLTS dial (12, figure 4-11) directly beneath the hairline of the power set indicator (13, figure 4-11).

w. Note the reading of the microwave power meter (in dbm).

x. Rotate the RF OSC control throughout the band in 100 mc increments. At each frequency, zero-set and power set the power monitor meter, and then adjust the OUTPUT ATTENUATOR control to position the 0 dbm mark of the -DBM MICROVOLTS dial directly beneath the hairline of the power set indicator. Note the microwave power meter reading at each frequency (in dbm). The difference between the maximum and minimum readings should not be greater than approximately 2 db.

y. Substitute the values obtained for the maximum and minimum output power into the following formula to obtain the average overall db error:

$$\text{Average overall db error} = \frac{P_{max}\ (\text{in dbm}) - P_{min}\ (\text{in dbm})}{2}$$

z. Rotate the RF OSC control to the low-power frequency and secure the setting by adjusting the LOCK control.

aa. Loosen the two setscrews that secure the OUTPUT ATTENUATOR control knob to its shaft.

ab. Remove the knob from the shaft.

ac. Loosen the two setscrews that secure the POWER SET control knob to its shaft.

ad. Remove the knob from the shaft.

ae. Loosen and remove the four screws, one located at each corner of the dial cover, and remove the dial cover from the tuning unit front panel assembly.

af. Zero-set and power-set the equipment.

ag. Adjust the OUTPUT ATTENUATOR control shaft to obtain a microwave power meter reading corresponding to one milliwatt minus the average overall db error obtained in step y.

ah. Loosen the two setscrews which secure the -DBM MICROVOLTS dial to its shaft.

ai. Rotate the OUTPUT ATTENUATOR control to position the 0 dbm mark of the -DBM MICROVOLTS dial beneath the hairline of the power set indicator.

aj. Tighten the two setscrews to secure the -DBM MICROVOLTS dial to its shaft.

ak. Recheck those frequencies covered in step x, above, for power output. At each frequency first zero zero-set the power monitor meter and then power-set the oscillator. Then adjust the OUTPUT ATTENUATOR control shaft to position the 0 dbm mark of the -DBM MICROVOLTS dial beneath the hairline of the power set indicator. Note the microwave power meter indication at each frequency. It should read 0 dbm ±1 db.

al. Replace the dial cover on the tuning unit front panel assembly.

am. Replace the OUTPUT ATTENUATOR and POWER SET control knobs on their shafts.

an. De-energize and disconnect the equipment.

ao. Replace the tuning unit into the basic unit.

4—29. SETTING REPETITION RATE.

4-30. To set the repetition rate of the free-running rate phantastron, proceed as indicated in the following steps:

a. Connect the equipment as illustrated in figure 4-17.

b. Program the MSG-1R/2R for internally synchronized pulse-modulated operation (refer to paragraph 2-15).

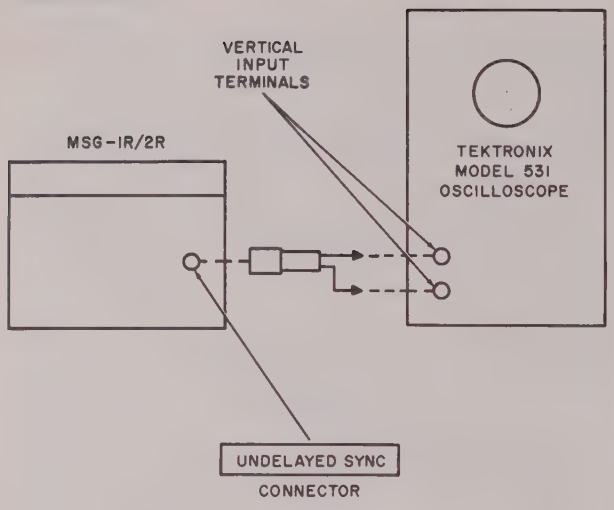
c. Set RATE CYCLES/SECOND switch to X100 and RATE CYCLES/SECOND control to 100.

d. Adjust Max PRF Adj. control R300 to obtain a counter indication of at least 10,000 pps.

e. Set RATE CYCLES/SECOND switch to X10 and note counter indication. It should indicate at least 1,000 pps.

f. Set RATE CYCLES/SECOND switch to X1 and note counter indication. It should indicate at least 100 pps.

g. De-energize and disconnect the equipment.



4-16. Setting Repetition Rate, Equipment Setup

4—31. SETTING SQUARE-WAVE SYMMETRY.

4-32. To optimize the symmetry of the internally synchronized square-wave-modulated r-f output signal, proceed as indicated in the following steps:

a. Connect the equipment as illustrated in figure 4-3.

b. Program the MSG-1R/2R for internally synchronized square-wave-modulated operation at a repetition frequency of 1,000 cps (refer to paragraph 2-14).

c. Adjust Symmetry Adj. control R321 to obtain a detected square-wave output signal having optimum symmetry.

d. De-energize and disconnect the equipment.

4—33. SETTING MAXIMUM DELAY.

4-34. To set the maximum delay of the delayed sync output pulse, proceed as indicated in the following steps:

a. Connect the equipment as illustrated in figure 4-4.

b. Program the MSG-1R/2R for internally synchronized pulse-modulated operation (refer to paragraph 2-15).

c. Set RATE CYCLES/SECOND control R301 and RATE CYCLES/SECOND switch S302 to obtain a repetition rate of 200 pps.

d. Set DELAY MICROSECONDS control R367 to 20 and DELAY MICROSECONDS switch S303 to X100.

e. Adjust Max Delay Adj. control R368 to obtain a delay of at least 2,000 microseconds.

f. Set DELAY MICROSECONDS switch S303 to X10 and note delay. It should be at least 200 microseconds.

g. Set DELAY MICROSECONDS switch S303 to X1 and note delay. It should be at least 20 microseconds.

h. De-energize and disconnect the equipment.

4—35. SETTING WIDTH OF OUTPUT PULSE.

4-36. To set the width of the output pulse, proceed as indicated in the following steps:

a. Connect the equipment as illustrated in figure 4-5.

b. Program the MSG-1R/2R for internally synchronized pulse-modulated operation (refer to paragraph 2-15) with minimum delay.

c. Set PULSE WIDTH MICROSECONDS control C332 to 10.

d. Adjust Max Width Adj. control R399 to obtain an output pulse 10 microseconds wide.

e. Set PULSE WIDTH MICROSECONDS control C332 to 0.3.

f. Adjust Min Width Adj. control C399 to obtain an output pulse 0.3 microseconds wide.

g. Repeat steps c through f to optimize results.

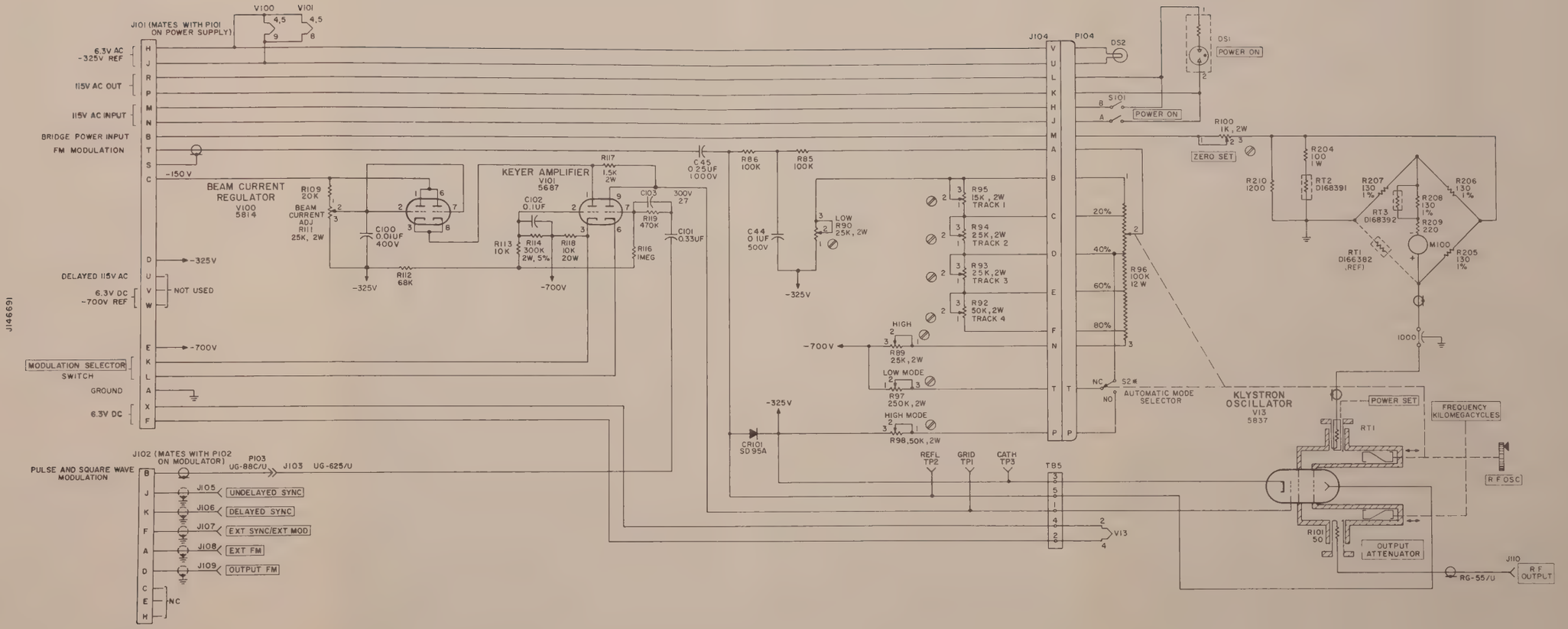
h. De-energize and disconnect the equipment.

SECTION V

SCHEMATIC DIAGRAMS

5-1. GENERAL

5-2. This section contains the schematic diagrams of both the Models MSG-1R and MSG-2R Microwave Signal Generators.



NOTE

ALL VALUES ARE EXPRESSED IN MICRO-MICROFARADS (UUF) MICROHENRIES (UH), AND OHMS, UNLESS SUFFIXED BY UF FOR MICROFARAD, MH FOR MILLIHENRY, H FOR HENRY, K FOR KILOHM OR MEG FOR MEGOHM.

CAPACITORS ARE RATED AT 10%, 400V DCW, UNLESS OTHERWISE INDICATED.

INDUCTORS ARE RATED AT 20%, 1000V DC TEST, UNLESS OTHERWISE INDICATED.

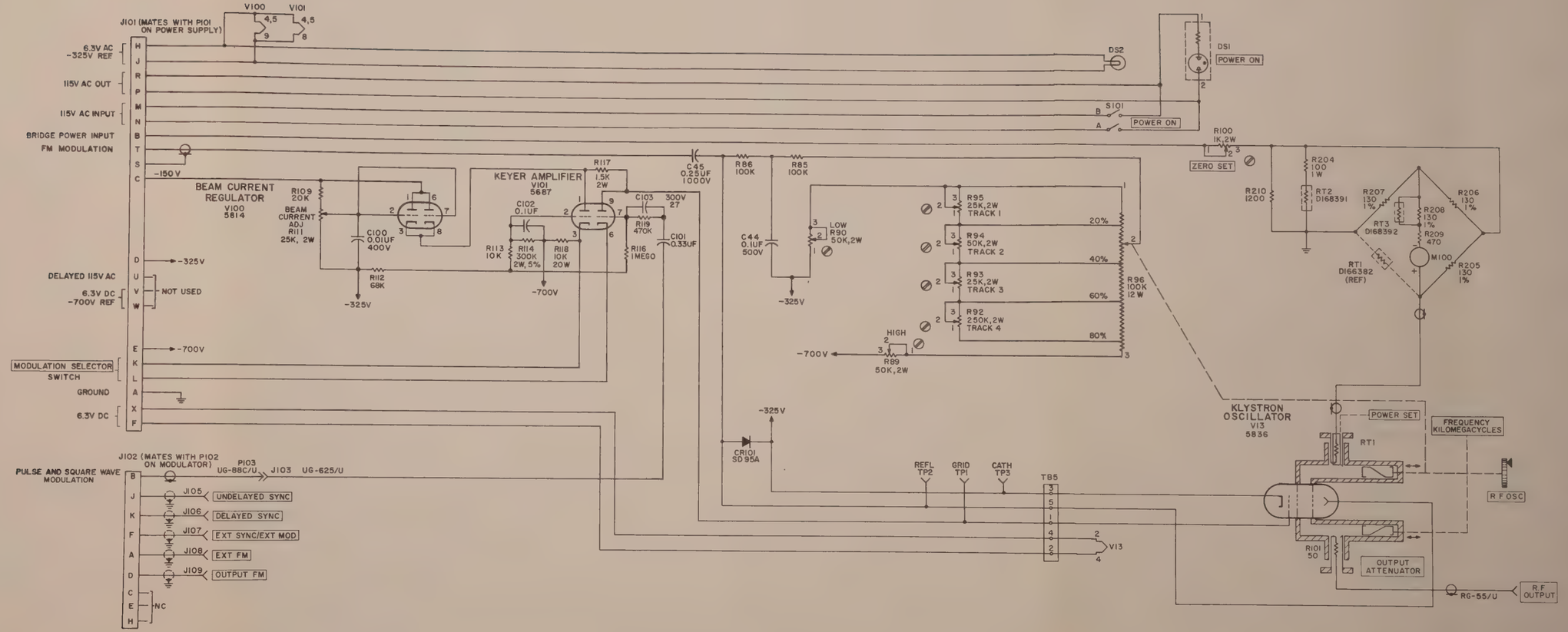
RESISTORS ARE RATED AT ±10%, 1/2 WATT, UNLESS OTHERWISE INDICATED.

▭ INDICATES EQUIPMENT PANEL MARKING

⊘ INDICATES SCREWDRIVER ADJUSTMENT.

* S2 CLOSES ABOVE 125C

Figure 5-1. Model MSG-1R Tuning Unit, Schematic Diagram



NOTE

ALL VALUES ARE EXPRESSED IN MICRO-MICROFARADS (UUF) MICROHENRIES (UH), AND OHMS, UNLESS SUFFIXED BY UF FOR MICROFARAD, MH FOR MILLIHENRY, H FOR HENRY, K FOR KILOHM OR MEGO FOR MEGOHM.

CAPACITORS ARE RATED AT 10%, 400V DCW, UNLESS OTHERWISE INDICATED.

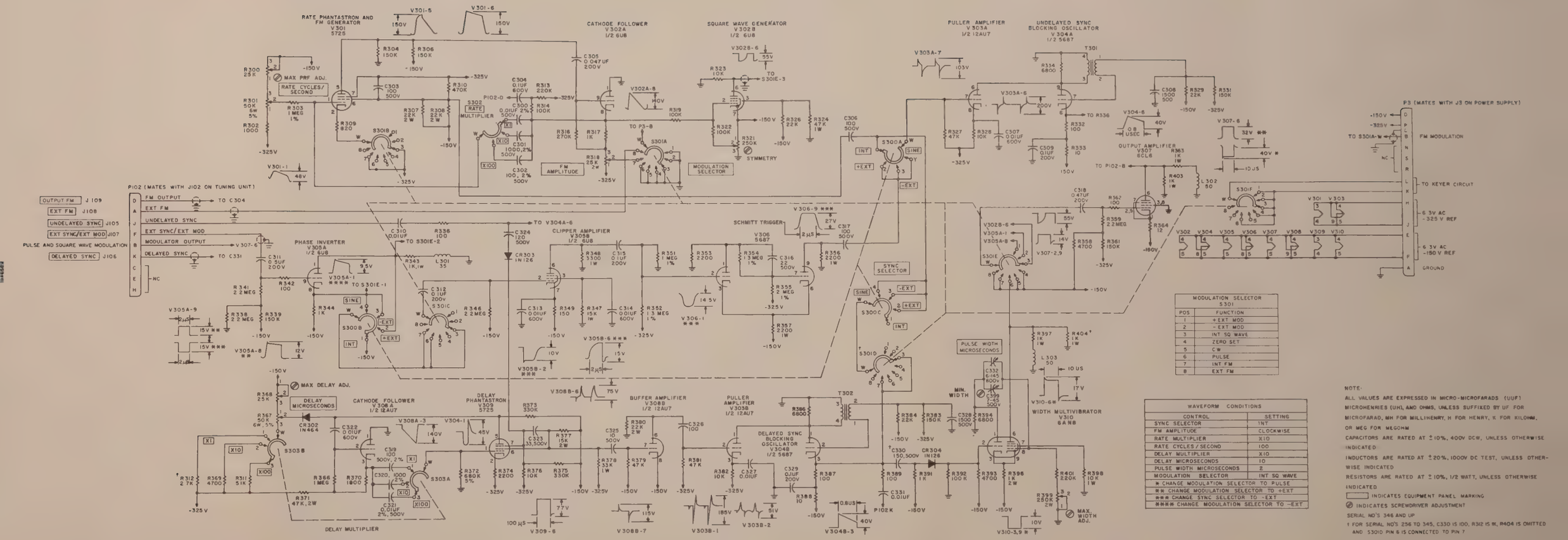
INDUCTORS ARE RATED AT 20%, 1000V DC TEST, UNLESS OTHERWISE INDICATED.

RESISTORS ARE RATED AT ±10%, 1/2 WATT, UNLESS OTHERWISE INDICATED.

▭ INDICATES EQUIPMENT PANEL MARKING.

⊘ INDICATES SCREWDRIVER ADJUSTMENT.

Figure 5-2. Model MSG-2R Tuning Unit, Schematic Diagram

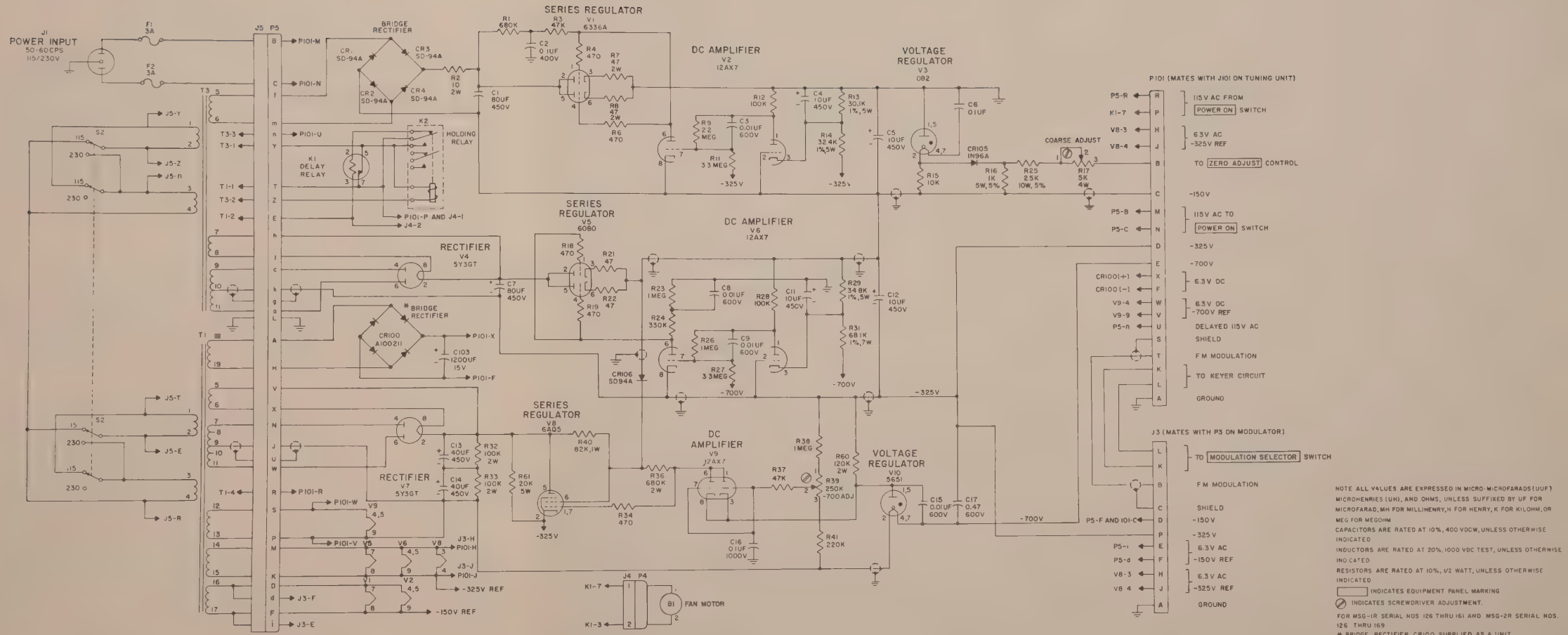


MODULATION SELECTOR S301	
POS	FUNCTION
1	+EXT MOD
2	-EXT MOD
3	INT SQ WAVE
4	ZERO SET
5	CW
6	PULSE
7	INT FM
8	EXT FM

WAVEFORM CONDITIONS	
CONTROL	SETTING
SYNC SELECTOR	INT
FM AMPLITUDE	CLOCKWISE
RATE MULTIPLIER	X10
RATE CYCLES / SECOND	100
DELAY MULTIPLIER	X10
DELAY MICROSECONDS	10
PULSE WIDTH MICROSECONDS	2
MODULATION SELECTOR	INT SQ WAVE
* CHANGE MODULATION SELECTOR TO PULSE	
** CHANGE MODULATION SELECTOR TO +EXT	
*** CHANGE SYNC SELECTOR TO -EXT	
**** CHANGE MODULATION SELECTOR TO -EXT	

NOTE:
ALL VALUES ARE EXPRESSED IN MICRO-MICROFARADS (UUF) MICROHENRIES (UH), AND OHMS, UNLESS SUFFIXED BY UF FOR MICROFARAD, MH FOR MILLIHENRY, H FOR HENRY, K FOR KILOHM, OR MEG FOR MEGOHM
CAPACITORS ARE RATED AT ±10%, 400V DCW, UNLESS OTHERWISE INDICATED
INDUCTORS ARE RATED AT ±20%, 1000V DC TEST, UNLESS OTHERWISE INDICATED
RESISTORS ARE RATED AT ±10%, 1/2 WATT, UNLESS OTHERWISE INDICATED
▭ INDICATES EQUIPMENT PANEL MARKING
⊘ INDICATES SCREWDRIVER ADJUSTMENT
SERIAL NO'S 346 AND UP
† FOR SERIAL NO'S 256 TO 345, C330 IS 100, R392 IS 1K, R404 IS OMITTED AND S301D PIN 6 IS CONNECTED TO PIN 7

Figure 5-3. Model GM-3 Pulse Modulator Unit, Schematic Diagram



NOTE ALL VALUES ARE EXPRESSED IN MICRO-MICROFARADS (UUF) MICROHENRIES (UH), AND OHMS, UNLESS SUFFIXED BY UF FOR MICROFARAD, MH FOR MILLIHENRY, H FOR HENRY, K FOR KILOHM, OR MEG FOR MEGOHM

CAPACITORS ARE RATED AT 10%, 400 VDCW, UNLESS OTHERWISE INDICATED

INDUCTORS ARE RATED AT 20%, 1000 VDC TEST, UNLESS OTHERWISE INDICATED

RESISTORS ARE RATED AT 10%, 1/2 WATT, UNLESS OTHERWISE INDICATED

[ ] INDICATES EQUIPMENT PANEL MARKING

⊘ INDICATES SCREWDRIVER ADJUSTMENT.

FOR MSG-1R SERIAL NOS 126 THRU 161 AND MSG-2R SERIAL NOS. 126 THRU 169

* BRIDGE RECTIFIER CR100 SUPPLIED AS A UNIT.

Figure 5-4. Model GB-1 Basic Unit, Schematic Diagram

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. This parts list provides an alpha-numerical listing, in reference symbol sequence of the replaceable electrical, certain electro-mechanical, and mechanical parts of the equipment.

6-3. ORDERING INFORMATION. Orders for parts should contain the following information:

a. Equipment name and model.
b. Serial number.
c. Reference symbol of part.
d. Manufacturer's part number and code.

6-4. HOW TO USE THE PARTS LIST.

6-5. An explanation of the structure of the parts list, Table 6-2, and the meaning of the entries in the five columns are given in the following paragraphs. (See Figure 6-1.)

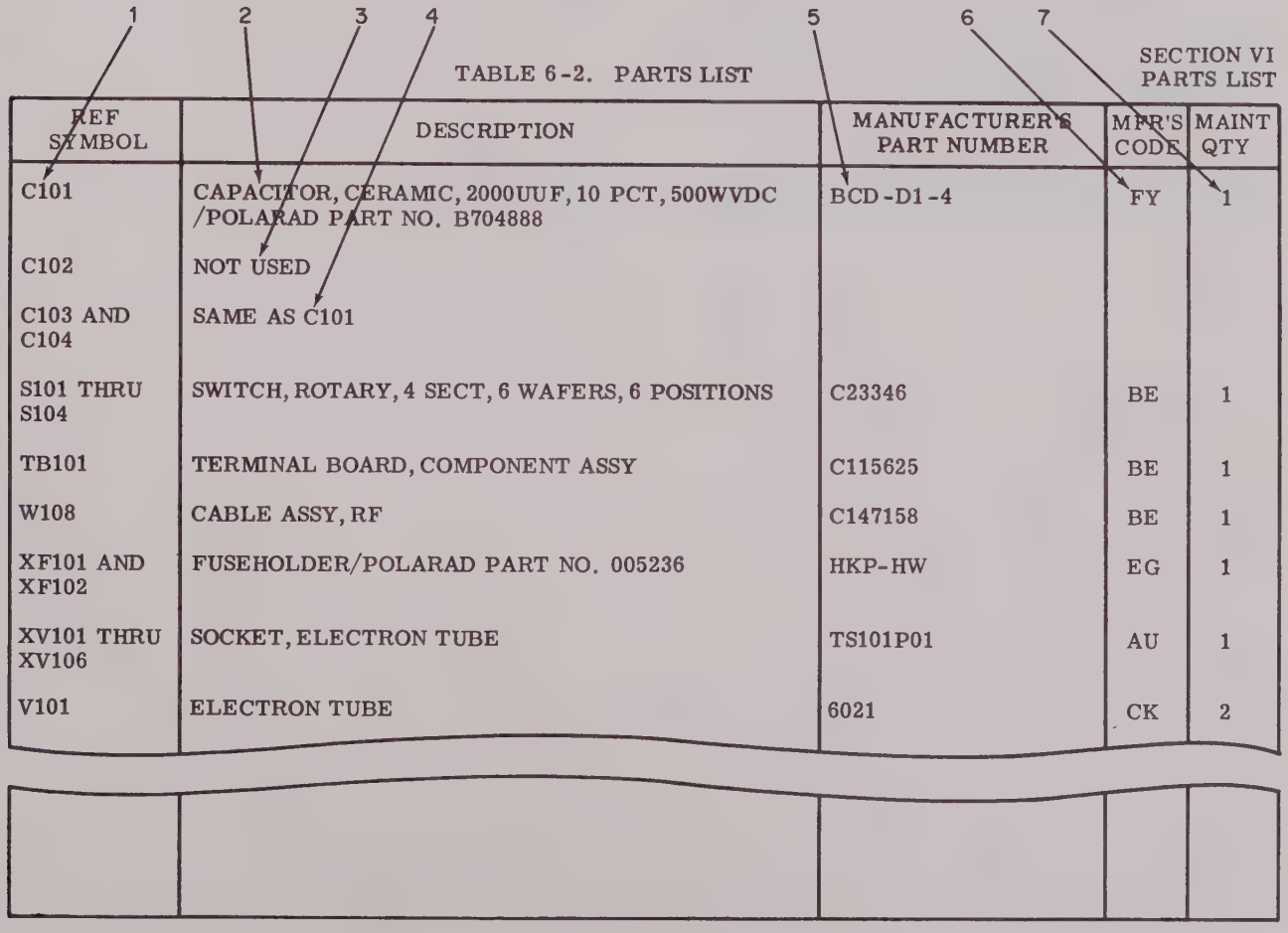


Figure 6-1. Parts List Example

6-6. REFERENCE SYMBOL COLUMN. The reference symbol column (1, Figure 6-1) contains the reference symbol assigned to each part, which also identifies the part on the schematic diagram or in an illustration. The listing is in alpha-numerical order.

6-7. DESCRIPTION COLUMN. The description column (2) contains the description for each part. When the same part is used more than once in the equipment, the second and subsequent listings for that part use the phrase "SAME AS ___" (4) in the description column and the remaining columns (5, 6, and 7) are left blank. When a reference symbol designation has not been used or its assignment has been cancelled, the description column contains the phrase "NOT USED" (3).

6-8. MANUFACTURER'S PART NUMBER COLUMN. The manufacturer's part number column (5) contains the part number assigned by the manufacturer of the part, except for "SAME AS ___" and "NOT USED" listings.

6-9. MANUFACTURER'S CODE COLUMN. The manufacturer's code column (6) contains a letter code identifying the manufacturer of the part. Table 6-1 contains a listing of the letter codes and the manufacturers names and addresses.

6-10. MAINTENANCE QUANTITY COLUMN. The maintenance quantity column (7) contains the recommended maintenance quantity for each part, based on a one year requirement for an equipment in operation for 10 hours a day throughout the year. The recommended maintenance quantities will provide a high degree of equipment reliability in areas where an adequate supply of replacement parts is not available. The recommended maintenance quantity is listed for the initial occurrence of the part in the parts list, but covers all subsequent listings.

6-11. To determine recommended maintenance quantity for periods other than one year, multiply the one-year quantity by the desired period, expressed in years.

6-12. To determine recommended maintenance quantity for operating periods other than 10 hours per day, use the equation given below.

$$MQ' = MQ \times \frac{HR_{op}}{10}$$

where: MQ = Maintenance quantity from Table 6-2

MQ' = Maintenance quantity for desired operating period

HR_{op} = Operating period in hours

Round off the quantity obtained to the nearest whole number.

TABLE 6-1. MANUFACTURERS CODE

CODE	NAME AND ADDRESS
AU	Military Specifications
BE	Polarad Electronics Corp. Long Island City, N.Y.
CK	Commercially Available Unit

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
	MODEL GB-1 BASIC UNIT			
B1	FAN,AXIAL	B702227	BE	1
CR1 THRU CR4	SEMICONDUCTOR DEVICE,DIODE	A709664	BE	1
CR100	RECTIFIER,GERMANIUM	A100211	BE	1
CR101 THRU CR104	NOT USED			
CR105	SEMICONDUCTOR,DIODE	1N964	CK	1
CR106	SAME AS CR1			
C1	CAPACITOR,80UF,450WVDC	A149389	BE	1
C2	CAPACITOR,PLASTIC,0.1UF,20 PCT,400WVDC	B508828	BE	1
C3	CAPACITOR,CERAMIC,0.01UF,600WVDC	A701874	BE	1
C4 AND C5	CAPACITOR,10UF,450WVDC	A149391	BE	1
C6	CAPACITOR,PLASTIC,0.1UF,20 PCT,200WVDC	B508728	BE	1
C7	SAME AS C1			
C8	SAME AS C4			
C9	SAME AS C3			
C10	NOT USED			
C11 AND C12	SAME AS C4			
C13 AND C14	CAPACITOR,40UF,450WVDC	A149388	BE	1
C15	SAME AS C3			
C16	CAPACITOR,PLASTIC,0.1UF,20 PCT,1000WVDC	B509028	BE	1
C17	CAPACITOR,PAPER,0.47UF,20PCT,600WVDC	A703955	BE	1
C18 THRU C102	NOT USED			
C103	CAPACITOR,ELECTROLYTIC,1200UF,15WVDC	CE51C122E	AU	1
F1 AND F2	FUSE,CARTRIDGE,3A	518127	BE	1
J1	CONNECTOR,RECEPTACLE	A700010	BE	1
J5	CONNECTOR SET,ELECTRICAL	A701496	BE	1
K1	SWITCH,THERMOSTATIC	B702097	BE	1
K2	RELAY,ARMATURE	B702095	BE	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
P1 AND P2	NOT USED			
P3	CONNECTOR,ELECTRICAL	B701693	BE	1
P4	CONNECTOR,MINEATURE,CABLE	A50124	BE	1
P5	CONNECTOR SET,ELECTRICAL	A701495	BE	1
P101	CONNECTOR SET,ELECTRICAL	A701469	BE	1
R1	RESISTOR,COMPOSITION,680K,10 PCT,1/2W	RC20GF684K	AU	1
R2	RESISTOR,COMPOSITION,10 OHMS,10 PCT,2W	RC42GF100K	AU	1
R3	RESISTOR,COMPOSITION,47K,10 PCT,1/2W	RC20GF473K	AU	1
R4	RESISTOR,COMPOSITION,470 OHMS,10 PCT,1/2W	RC20GF471K	AU	1
R5	NOT USED			
R6	SAME AS R4			
R7 AND R8	RESISTOR,COMPOSITION,47 OHMS,10 PCT,2W	RC42GF470K	AU	1
R9	RESISTOR,COMPOSITION,2.2 MEGO,10 PCT,1/2W	RC20GF225K	AU	1
R10	NOT USED			
R11	RESISTOR,COMPOSITION,3.3MEGO,10 PCT,1/2W	RC20GF335K	AU	1
R12	RESISTOR,COMPOSITION,100K,10 PCT,1/2W	RC20GF104K	AU	1
R13	RESISTOR,WIRE WOUND,30.1K,1 PCT,5W	B704428	BE	1
R14	RESISTOR,WIRE WOUND,32.4K,1 PCT,5W	B704426	BE	1
R15	RESISTOR,COMPOSITION,10K,10 PCT,1/2W	RC20GF103K	AU	1
R16	RESISTOR,WIRE WOUND,1K,5 PCT,5W	A710360	BE	1
R17	RESISTOR,VARIABLE,5K,10 PCT,4W	RA30A2SD502AK	AU	1
R18 AND R19	SAME AS R4			
R20	NOT USED			
R21 AND R22	RESISTOR,COMPOSITION,47 OHMS,10 PCT,1/2W	RC20GF470K	AU	1
R23	RESISTOR,COMPOSITION,1 MEGO,10 PCT,1/2W	RC20GF105K	AU	1
R24	RESISTOR,COMPOSITION,330K,10 PCT,1/2W	RC20GF334K	AU	1
R25	RESISTOR,WIRE WOUND,2.5K,5 PCT,10W	B708646	BE	1
R26	SAME AS R23			
R27	SAME AS R11			
R28	SAME AS R12			
R29	RESISTOR,WIRE WOUND,34.8K,1 PCT,5W	B704427	BE	1
R30	NOT USED			
R31	RESISTOR,WIRE WOUND,68.1K,1 PCT,7W	A710344	BE	1
R32 AND R33	RESISTOR,COMPOSITION,100K,10 PCT,2W	RC42GF104K	AU	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
R34	SAME AS R4			
R35	NOT USED			
R36	RESISTOR,COMPOSITION,680K,10 PCT,2W	RC42GF684K	AU	1
R37	SAME AS R3			
R38	SAME AS R23			
R39	RESISTOR,VARIABLE,250K,10 PCT,2W,TAPER U	517914	BE	1
R40	RESISTOR,COMPOSITION,82K,10 PCT,1W	RC32GF823K	AU	1
R41	RESISTOR,COMPOSITION,220K,10 PCT,1/2W	RC20GF224K	AU	1
R42 THRU R59	NOT USED			
R60	RESISTOR,COMPOSITION,120K,10 PCT,2W	RC42GF124K	AU	1
R61	RESISTOR,WIRE WOUND,20K,5 PCT,5W	A710359	BE	1
S2	SWITCH,ROTARY	A137213	BE	1
TB01	ASSY,TERMINAL BOARD	C129641	BE	1
TB02	ASSY,TERMINAL BOARD	A129646	BE	1
T1	TRANSFORMER			
T2	NOT USED	B142922	BE	1
T3	TRANSFORMER	B114776	BE	1
V1	ELECTRON TUBE	6336	CK	2
V2	ELECTRON TUBE	12AX7	CK	6
V3	ELECTRON TUBE	0B2	CK	2
V5	ELECTRON TUBE	6080	CK	2
V6	SAME AS V2			
V7	SAME AS V4			
V8	ELECTRON TUBE	6AQ5	CK	2
V9	SAME AS V2			
V10	ELECTRON TUBE	5651	CK	2
XC103	SOCKET	TS101P01	AU	1
XK1	SAME AS XC103			
XV1	SAME AS XC103			
XV2	SOCKET	TS103P01	AU	1
XV3	SOCKET	TS102P01	AU	1
XV4	SAME AS XC103			
XV5	SAME AS XC103			
XV6	SAME AS XV2			
XV7	SAME AS XC103			

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
XV8	SAME AS XV3			
XV9	SOCKET,ELECTRON TUBE	506711	BE	1
XV10	SOCKET,ELECTRON TUBE	506710	BE	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
	MSG-2R TUNING UNIT			
A1	COMPONENT ASSY	D146569	BE	1
CR101	SEMICONDUCTOR DEVICE,DIODE	A701909	BE	1
C1 THRU C43	NOT USED			
C44	CAPACITOR,CERAMIC,0.1UF,PLUS 80 PCT,MINUS 20 PCT,500WVDC	A702290	BE	1
C45	CAPACITOR,FIXED,0.25UF,10 PCT	B710291	BE	1
C46 THRU C99	NOT USED			
C100	CAPACITOR,CERAMIC,0.01UF,600WVDC	A701874	BE	1
C101	CAPACITOR,PAPER,0.33UF,20 PCT,600WVDC	CP05A1KF334K	BE	1
C102	SAME AS C44			
C103	CAPACITOR,MICA,270UUF,10 PCT,500WVDC	CM15C270K	AU	1
DS1	LAMP,GLOW	AK 5238	BE	1
DS2	LAMP,INCANDESCENT	005237	BE	2
H101	KNOB,CRANK HANDLE	005482	BE	1
H102	KNOB,DIAL TYPE	517207	BE	1
M100	AMMETER	B702858	BE	1
J101	CONNECTOR SET,ELECTRICAL	A701470	BE	1
J102	CONNECTOR SET,ELECTRICAL	B702904	BE	1
J103 THRU J104	NOT USED			
J105 THRU J109	CONNECTOR,RECEPTACLE	UG657/U	AU	1
R1 THRU R15	NOT USED			
R16 AND R17	RESISTOR,VARIABLE,50K,10 PCT,2W,TAPER U	517853	BE	1
R18 THRU R84	NOT USED			
R85 AND R86	RESISTOR,COMPOSITION,100K,10 PCT,1/2W	RC20GF104K	AU	1
R87 THRU R91	NOT USED			
R92	RESISTOR,VARIABLE,250K,10 PCT,2W,TAPER U	517925	BE	1
R93	RESISTOR,VARIABLE,25K,10 PCT,2W,TAPER U	517851	BE	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
R94	SAME AS R16			
R95	SAME AS R93			
R96	RESISTOR,VARIABLE,100K,1 PCT,12W	CP17230	BE	1
R97 THRU R108	NOT USED			
R109	RESISTOR,COMPOSITION,20K,5 PCT,1/2W	RC20GF203J	AU	1
R110	NOT USED			
R111	SAME AS R93			
R112	RESISTOR,COMPOSITION,68K,10 PCT,1/2W	RC20GF683K	AU	1
R113	RESISTOR,COMPOSITION,10K,10 PCT,1/2W	RC20GF103K	AU	1
R114	RESISTOR,COMPOSITION,300K,5 PCT,2W	RC42GF304J	AU	1
R115	NOT USED			
R116	RESISTOR,COMPOSITION,1 MEGO,10 PCT,1/2W	RC20GF105K	AU	1
R117	RESISTOR,COMPOSITION,1.5K,10 PCT,2W	RC42GF152K	AU	1
R118	RESISTOR,WIREWOUND,10K,5 PCT,12W	RW32V103	AU	1
R119	RESISTOR,COMPOSITION,470K,10 PCT,1/2W	RC20GF474K	AU	1
R120 THRU R202	NOT USED			
R203	RESISTOR,VARIABLE,1K,10 PCT,2W,TAPER U	517843	BE	1
R204	RESISTOR,COMPOSITION,100 OHMS,10 PCT,1W	RC32GF101K	AU	1
R205 THRU R208	RESISTOR,FILM,130 OHMS,1 PCT,1/2W	RN20R1300F	AU	1
R209	RESISTOR,COMPOSITION,470 OHMS,10 PCT,1/2W	RC20GF471K	AU	1
R210	RESISTOR,COMPOSITION,1.2K,10 PCT,2W	RC42GF122K	AU	1
RT1	NOT USED			
RT2	THERMISTOR,DISC	B510511	BE	1
RT3	THERMISTOR,DISC	B510512	BE	1
S101	SWITCH,TOGGLE	MS25100-23	AU	1
TB1	TERMINAL BOARD	C146566	BE	1
TB5	TERMINAL BOARD	B704560	BE	1
TP1	TEST JACK,BLACK	A514201	BE	1
TP2	TEST JACK,RED	A514202	BE	1
TP3	TEST JACK,BLUE	A514203	BE	1
V13	REFLEX KLYSTRON	AK50045	BE	2
V100	ELECTRON TUBE	5814	CK	2
V101	ELECTRON TUBE	5687	CK	2
W1	CABLE ASSY,POWER,ELECTRICAL	B111144	BE	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
W402	CABLE ASSEMBLY	P12553	BE	1
XDS1	LIGHT,INDICATOR,RED	524108	BE	1
XDS2	SOCKET,LAMP	AK5633	BE	1
XV100 AND XV101	SOCKET,ELEC TUBE	TS103P01	AU	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
	MODEL GM-3 PULSE MODULATOR UNIT			
CR301	NOT USED			
CR302	SEMICONDUCTOR DEVICE,DIODE	1N464	CK	1
CR303 AND CR304	SEMICONDUCTOR DEVICE,DIODE	1N126	CK	1
C300	CAPACITOR,MICA,103UUF,2 PCT,500WVDC	CM07F103G	AU	1
C301	CAPACITOR,MICA,102UUF,2 PCT,500WVDC	CM06F102G	AU	1
C302	CAPACITOR,MICA,101UUF,2 PCT,500WVDC	CM05F101G	AU	1
C303	CAPACITOR,MICA,100UUF,10 PCT,500WVDC	B703031	BE	1
C304	CAPACITOR,PLASTIC,0.1UF,20 PCT,600WVDC	B508928	BE	1
C305	CAPACITOR,PLASTIC,0.047UF,20 PCT,200WVDC	B508724	BE	1
C306	SAME AS C303			
C307	CAPACITOR,CERAMIC,0.01UF,600WVDC	A701874	BE	1
C308	CAPACITOR,MICA,152UUF,10 PCT,500WVDC	CM30B152K	AU	1
C309	CAPACITOR,PLASTIC,0.1UF,20 PCT,200WVDC	B508728	BE	1
C310	CAPACITOR,PLASTIC,0.01UF,20 PCT,400WVDC	B508816	BE	1
C311	CAPACITOR,PAPER,0.5UF,20 PCT,200WVDC	A702149	BE	1
C312	SAME AS C309			
C313 AND C314	SAME AS C307			
C314	NOT USED			
C315	SAME AS C309			
C316	CAPACITOR,MICA,22UUF,10 PCT,500WVDC	B703114	BE	1
C317	CAPACITOR,MICA,101UUF,10 PCT,500WVDC	CM20B101K	AU	1
C318	CAPACITOR,PLASTIC,0.47UF,20 PCT,200WVDC	B508733	BE	1
C319	SAME AS C302			
C320	SAME AS C301			
C321	SAME AS C300			
C322	SAME AS C307			
C323	CAPACITOR,MICA,33UUF,10PCT,500WVDC	B70318	BE	1
C324	CAPACITOR,MICA,121UUF,10 PCT,500WVDC	CM20B121K	AU	1
C325	CAPACITOR,MICA,10UUF,10 PCT,500WVDC	B703009	BE	1
C326	SAME AS C317			

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
C327	SAME AS C307			
C328	SAME AS C303			
C329	SAME AS C309			
C330	CAPACITOR,MICA,150UUF,10 PCT,500WVDC	B703035	BE	1
C331	SAME AS C316			
C332	CAPACITOR,VARIABLE,6.0-145UUF,800WVDC	A115502	BE	1
C399	CAPACITOR,VARIABLE,7-45UUF,500WVDC	CV11C450	AU	1
H301 AND H302	KNOB	B115403	BE	1
H303 AND H304	KNOB,POINTER TYPE	507403	BE	1
H305 AND H306	KNOB,DIAL TYPE	517211	BE	1
H307 AND H308	KNOB,POINTED	A702475	BE	1
L301	COIL,RF,35HY	A144368	BE	1
L302 AND L303	COIL,RF,50HY	A144367	BE	1
R301	RESISTOR,VARIABLE,50K,5 PCT,6W	A701360	BE	1
R302	RESISTOR,COMPOSITION,1K,10 PCT,1/2W	RC20GF102K	AU	1
R303	RESISTOR,FILM,1 MEGO,1 PCT,1/2W	RN20X1004F	AU	1
R304	RESISTOR,COMPOSITION,150K,10 PCT,1/2W	RC20GF154K	AU	1
R305	NOT USED			
R306	SAME AS R304			
R307	SAME AS R303			
R308	RESISTOR,COMPOSITION,22K,10 PCT,2W	RC42GF223K	AU	1
R309	RESISTOR,COMPOSITION,820 OHMS,10 PCT,1/2W	RC206F821K	AU	1
R311 AND R312	NOT USED			
R313	RESISTOR,COMPOSITION,220K,10 PCT,1/2W	RC20GF224K	AU	1
R314	RESISTOR,COMPOSITION,100K,10 PCT,1/2W	RC20GF104K	AU	1
R315	NOT USED			
R316	RESISTOR,COMPOSITION,270K,10 PCT,1/2W	RC20GF274K	AU	1
R317	SAME AS R302			
R318	RESISTOR,VARIABLE,COMPOSITION,25K,20 PCT,2W	C708765	BE	1
R319	SAME AS R314			
R320	NOT USED			
R321	RESISTOR,VARIABLE,250K,10 PCT,2W	517925	BE	1
R322	SAME AS R314			

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
R323	RESISTOR,COMPOSITION,10K,10 PCT,1/2W	RC20GF103K	AU	1
R324	RESISTOR,COMPOSITION,47K,10 PCT,1/2W	RC32GF473K	AU	1
R325	NOT USED			
R326	RESISTOR,COMPOSITION,22K,10 PCT,1/2W	RC20GF223K	AU	1
R327	RESISTOR,COMPOSITION,47K,10 PCT,1/2W	RC20GF473K	AU	1
R328	SAME AS R323			
R329	SAME AS R326			
R330	NOT USED			
R331	SAME AS R304			
R332	RESISTOR,COMPOSITION,100 OHMS,10 PCT,1/2W	RC20GF101K	AU	1
R333	RESISTOR,COMPOSITION,10 OHMS,10 PCT,1/2W	RC20GF100K	AU	1
R334	RESISTOR,COMPOSITION,6.8K,10 PCT,1/2W	RC20GF682K	AU	1
R335	NOT USED			
R336	SAME AS R332			
R337	NOT USED			
R338	RESISTOR,COMPOSITION,2.2 MEGO,10 PCT,1/2W	RC20GF225K	AU	1
R339	SAME AS R304			
R340	NOT USED			
R341	SAME AS R338			
R342	SAME AS R332			
R343	RESISTOR,COMPOSITION,1K,10 PCT,1/2W	RC32GF102K	AU	1
R344	SAME AS R302			
R345	NOT USED			
R346	SAME AS R338			
R347	RESISTOR,COMPOSITION,15K,10 PCT,1/2W	RC32GF153K	AU	1
R348	RESISTOR,COMPOSITION,3.3K,10 PCT,1/2W	RC32GF332K	AU	1
R349	RESISTOR,COMPOSITION,150 OHMS,10 PCT,1/2W	RC20GF151K	AU	1
R350	NOT USED			
R351	SAME AS R303			
R352	RESISTOR,FILM,1.3 MEGO,1 PCT,1/2W	RN20X1304F	AU	1
R353	RESISTOR,COMPOSITION,2.2K,10 PCT,1/2W	RC20GF222K	AU	1
R354	SAME AS R352			
R355	RESISTOR,FILM,2 MEGO,1 PCT,1/2W	RN20X2004F	AU	1
R356 AND R357	RESISTOR,COMPOSITION,2.2K,10 PCT,1/2W	RC32GF22K	AU	1
R358	RESISTOR,COMPOSITION,4.7K,10 PCT,1/2W	RC20GF472K	AU	1

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
R359	SAME AS R338			
R360	NOT USED			
R361	SAME AS R304			
R362	SAME AS R332			
R363	SAME AS R343			
R364	RESISTOR,COMPOSITION,12.OHMS,10 PCT,1/2W	RC20GF120K	AU	1
R365	NOT USED			
R366	RESISTOR,COMPOSITION,1 MEGO,10 PCT,1/2W	RC20GF105K	AU	1
R367	SAME AS R301			
R368	SAME AS R300			
R369	SAME AS R358			
R370	RESISTOR,COMPOSITION,1.8K,10 PCT,1/2W	RC20GF182K	AU	1
R371	RESISTOR,COMPOSITION,47K,10 PCT,1/2W	RC42GF473K	AU	1
R372	RESISTOR,COMPOSITION,680K,10 PCT,1/2W	RC20GF684K	AU	1
R373	RESISTOR,COMPOSITION,330K,10 PCT,1/2W	RC20GF334K	AU	1
R374	SAME AS R353			
R375	SAME AS R373			
R376	SAME AS R323			
R377	RESISTOR,COMPOSITION,15K,10 PCT,2W	RC42GF153K	AU	1
R378	RESISTOR,COMPOSITION,33K,10 PCT,1/2W	RC32GF333K	AU	1
R379	SAME AS R327			
R380	SAME AS R303			
R381	SAME AS R327			
R382	SAME AS R323			
R383	SAME AS R304			
R384	SAME AS R326			
R385	NOT USED			
R386	SAME AS R334			
R387	SAME AS R332			
R388	SAME AS R333			
R389	SAME AS R332			
R390	NOT USED			
R391	SAME AS R302			
R392	SAME AS R314			
R393	SAME AS R358			
R394	SAME AS R334			

REF SYMBOL	DESCRIPTION	MANUFACTURER'S PART NUMBER	MFR'S CODE	MAINT QTY
R395	NOT USED			
R397	SAME AS R343			
R398	RESISTOR,COMPOSITION,10K,10 PCT,1/2W	RC32GF103K	AU	1
R399	SAME AS R321			
R400	NOT USED			
R401	SAME AS R313			
S300	SWITCH,ROTARY	B706539	BE	1
S301	SWITCH,ROTARY	A126231	BE	1
S302 AND S303	SWITCH,ROTARY	B118808	BE	1
TB301	BOARD,COMPONENT	C118807	BE	1
TB302	BOARD,COMPONENT	C118799	BE	1
TB303	BOARD,COMPONENT	C118803	BE	1
T301	TRANSFORMER,PULSE	A710265	BE	1
T302	SAME AS T301			
V301	ELECTRON TUBE	5725	CK	1
V302	ELECTRON TUBE	6U8	CK	1
V303	ELECTRON TUBE	12AU7	CK	1
V304	ELECTRON TUBE	5687	CK	1
V305	SAME AS V302			
V306	SAME AS V304			
V307	ELECTRON TUBE	6CL6	CK	1
V308	SAME AS V303			
V309	SAME AS V301			
V310	ELECTRON TUBE	6AN8	CK	1
XV301	SOCKET		AU	1
XV302 THRU XV308	SOCKET		AU	1
XV309	SAME AS XV301			
XV310	SAME AS XV302			
V4	ELECTRON TUBE	5Y367	CK	4
R300	RESISTOR,VARIABLE,25K,10 PCT,2W,TAPER U	517869	BE	1
R310	RESISTOR,COMPOSITION,470K,10 PCT,1/2W	RC20GF474K	AU	1
R396	RESISTOR,COMPOSITION,100 OHMS,10 PCT,1/2W	RC42GF102K	AU	1

POLARAD

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